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AND

THERAPEUTICS



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MATERIA MEDICA, PHARMACOLOGY

AND

THERAPEUTICS

INORGANIC SUBSTANCES

BY

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TO

SIR THOMAS R. FRASER, M.D., LL.D., F.R.S.,

PROFESSOR OF MATERIA MEDICA AND CLINICAL MEDICINE IN THE
UNIVERSITY OF EDINBURGH,

THIS BOOK IS DEDICATED

AS AN

EXPRESSION OF ESTEEM FOR HIS PROFESSIONAL ABILITY

AND OF

GRATITUDE FOR MUCH PERSONAL KINDNESS.

PREFACE.

THE first edition of this work was published in 1882, the second in 1894. This, the third edition, although on the same lines, is almost a new book.

Every page has been carefully revised, many entirely re-written, especially in the sections on Oxygen, Nitrous oxide, Baths and Waters, Arsenic, Silver, Iron, Mercury, etc., and observations have been added on such new departures as the use of Cacodylates, Glycerophosphates and Uranium, Antitoxin for Diphtheria and Tetanus, Open Air for Tuberculosis, Radiant Heat and Light for Rheumatism, Lupus, etc., as well as accounts of recent work on the physiological action of drugs.

The therapeutical section remains in great measure the reflection of personal experience derived from a long and active practice, tested and modified by the best published and unpublished experience of others similarly placed ; but it is to be understood that all the curative measures recommended are really but helps to the *vis medicatrix naturæ*, and it is believed that the value of the present work to the practical man will prove to be not less in its suggestiveness than in its dogmatic statements.

Alphabetical order has been the main principle followed, but in different divisions—the Gases and Non-metallic Elements first, then the Halogens (Iodine first), then Water in

its various modes of use, and afterwards the Acids before the Metals ; of these last, the order is that of their Latin names, though the heading of the pages is in English.

Space has been economised by omitting paragraphs now out of date, and also methods of preparation, and by using smaller type for the characters and tests of the pharmaceutical preparations. Information on these points can be better obtained from works of another category. References to original memoirs are given in the text as fully as possible.

A second volume of this new edition — on the Vegetable, Animal and other compounds—is already in course of preparation.

My hearty thanks for assistance in preparing and correcting proofs and for many valuable suggestions are due to Dr. Edward Mackey of Brighton, also to Dr. Murrell and Dr. Arthur Whiting. My special thanks are due to Dr. Mackey for the great assistance he has given me in almost re-writing the Index to Diseases and Remedies, which has some special characters and will be found, I trust, of high practical utility to the busy practitioner.

A separate Index for Remedies only, as in the last edition, seems now scarcely required ; they are sufficiently indicated in the Contents, but a special list of Spas and Waters is given at the end.

Note.—I find, on revision, that some of the fractional changes in the equivalents of Elements have, by an oversight, not been printed in the text, or estimated in the formulæ of combining proportions, which may now be found only approximately correct. From Aluminium onwards the new equivalents have been added in brackets to the headings. For the preceding Elements they may be here set down for reference: Oxygen 15·88, Nitrogen 13·94, Carbon 11·91, Sulphur 31·82, Phosphorus 30·80, Iodine 125·90, Bromine 79·35, Chlorine 35·19.

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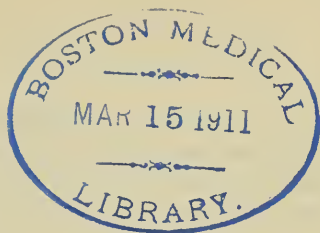
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MATERIA MEDICA

AND

THERAPEUTICS.

INORGANIC SUBSTANCES.

OXYGEN ($O = 16$). *Not Official.*

OXYGEN is the most universally diffused element in nature, forming part of the air, the water, the earth, and the tissues of plants and animals. Of the air it constitutes 23.01 per cent. by weight, 20.81 per cent. by measure, being about one-fifth part. By Priestley, who discovered it in 1774, it was named "dephlogisticated or vital air." The name oxygen (acid producer) was given to the gas by Lavoisier in 1778.

CHARACTERS.—The chief characteristic of oxygen is its energetic power of combining with organic principles and minerals to form oxides, acids, and bases—for instance, with hydrogen to form water. It is a gas, devoid of colour, odour, or taste, of sp. gr. 1.1057 (atmospheric air being taken as 1). Under a pressure of 320 atmospheres, and at a temperature of -220° F., it was liquefied by Pictet (1877), and in this form is colourless and transparent. By the Brin process oxygen is absorbed from the air by caustic baryta exposed at a high temperature under pressure. The peroxide yields oxygen at a lower temperature; another process of obtaining oxygen from air, said to be mainly mechanical, has lately been introduced by Pictet.

Professor Dewar (1892) produced liquid oxygen in pints, and showed that it boiled in air at 182° C. below zero; its chemical reactions disappear in the liquid form—for instance, phosphorus may be added to it without change, but its magnetic properties are intensified; it leaps up to the poles of a magnet and remains there till it disappears as gas: it is almost a non-conductor of electricity.

ABSORPTION.—The mode of absorption of oxygen in the lung is still under discussion. Whilst Pflüger and others hold that the tension of the oxygen in the air of the alveoli is greater than in the blood, and consequently that the gas passes inwards, in accordance with the laws of diffusion, Bohr, Haldane, Lorrain Smith and others maintain an opposite view as to the tension, and hold that the epithelial cells of the lungs remove oxygen from the air and abstract carbon dioxide from the blood.

PHYSIOLOGICAL ACTION.—*External.*—The external and local action of oxygen when in contact with mucous membranes or denuded skin is moderately stimulating and antiseptic.

PHYSIOLOGICAL ACTION.—*Internal.*—To describe fully the physiological action of oxygen would involve a description not only of the process of respiration, but of the other functions of the body, for it is essential to life itself. If it be deficient in the respired air, or if it be insufficiently absorbed, all the functions become disordered, and if its access to the lungs be prevented for a few minutes, life ceases. But we are concerned, at present, only with the results of certain experiments in which animals and men have been made to respire either pure oxygen, or an atmosphere artificially charged with a definite proportion of the gas, and the first question that arises is whether more than a normal amount of oxygen can be taken into the blood under such circumstances.

It was early concluded that animals kept under a bell-jar filled with oxygen lived longer than in ordinary air; and that animals made to breathe oxygen could resist asphyxia longer than similar animals that had breathed only air (Priestley, Beddoes), but Regnault and Reiset, whilst corroborating the former observation, maintained from a series of experiments that breathing an atmosphere rich in oxygen, or even one of the pure gas, did *not* make the blood take up more oxygen than it would from ordinary air, nor was more carbonic acid excreted in consequence (*Annales de Chimie*, 1844): their conclusions, however, which had much influence on professional opinion at the time, have been disproved. Preyer showed that ordinary arterial blood can take up more oxygen when shaken with the gas. Demarquay proved that suppurating, indolent, or unhealthy wounds on the extremities of animals became quickly florid and hyperæmic when pure oxygen

was inhaled—an extra amount of the stimulating gas must clearly have been carried by the circulation to the wound.

Gubler concluded that the blood receives the gas in proportion to its physical capacity for it, rather than in proportion merely to the vital necessity of hæmatosis: the globules absorb what they need, whilst any excess circulates free, and enters into combination only as the hæmoglobin loses oxygen in passing through the capillaries.

In the healthy animal, breathing ordinary air, the blood without doubt contains as much oxygen as the tissues need—the hæmoglobin of the arterial blood is saturated. But in many diseases the condition is different: owing to diminished absorption of oxygen in the lungs the blood is often abnormally venous and too little oxygen is taken to the tissues. In these cases the breathing of pure oxygen or air under pressure is of service, for the percentage of oxygen in the alveolar air is thus increased, and the pure oxygen diffusing more rapidly through the respiratory passages than the atmospheric oxygen, the blood in the lungs takes up more of it: it has been calculated to take up—in *simple solution*—five times as much as it would by breathing air at the same pressure. “In a man breathing air there is in arterial blood about 18·5 p.c. by volume of oxygen in combination with hæmoglobin, and 0·6 p.c. in simple solution: when pure oxygen is breathed, there is about 18·7 p.c. in combination—3 p.c. in solution—an extra 2·6 p.c.” (Hale White, *Text-book of Pharmacology*). “When hæmoglobin is deficient, or its oxygen-carrying power is damaged by poisons, etc., this oxygen in simple solution is of much importance, and breathing the pure gas will support life in an animal that can no longer live in air” (*Ibid.*).

Bert found that excess of oxygen, under a pressure of three atmospheres, produced tetanic symptoms and death, not due to simple increase of pressure, as air at a similar pressure had no such effect. Lorrain Smith has more recently found that oxygen at high tension will produce pneumonia as well as tetanoid spasms in mice in about sixty hours: the former effect is to be attributed to the influence of the tension of the gas upon the epithelial cells of the lungs (B. M. J., ii., 1898).

Direct Influence of Oxygen on the Heart.—Some observations by Cyon on this subject deserve notice. Separating the

heart of a frog, he connected it with a system of glass tubes and a manometer, and then passed through its cavities first serum saturated with carbonic acid gas, and afterwards serum saturated with oxygen. The former caused sudden arrest in diastole, whilst the latter restored the movements of the heart. Sir John Erichsen found, in experiments on asphyxiated animals, that ventricular contraction could be re-excited by oxygen when ordinary air had no effect. According to Hermann oxygen is not indispensable for the cardiac contractions—they may occur without it, but irregularly; if the gas be absent, or supplied in insufficient quantity, *regular and synchronous* contractions are impossible (Journ. d'Anat. et de Physiol., 1868-70).

Musculo-Nervous System.—The necessity of oxygen for the proper activity of the nervous and muscular systems is shown by the increased absorption of the gas during muscular work. Too small a supply of oxygen diminishes the activity of the nerve-cells, so that even unconsciousness may result.

Compressed Air.—Physiological Action.—This varies somewhat according as the patient is wholly immersed in an atmosphere of air compressed $\frac{1}{2}$ to 1 atmosphere in a closed chamber for one or two hours, or whether he simply breathes it from a reservoir through a tube with closely-fitting mouthpiece for 20 to 60 inspirations.

The former and older method, as carried out at Reichenhall, Tölz, etc., often caused oppression of head, tinnitus and acute pain in ears, and other disagreeable sensations, but had a sedative and equalising effect on the circulation, slowing the heart's action, raising arterial tension and altering the distribution of blood, lessening its amount in the veins and increasing it in the arteries. It increased also expectoration and excretion (Burdon Sanderson, Pract., i.).

In the more recent method employed by Waldenburg and Biedert, the extra compression amounts to only $\frac{1}{100}$ to $\frac{1}{45}$ atmosphere, and the good results obtained are more clearly traceable to the extra amount of oxygen. Nutrition and blood formation are improved, the "lesser circulation" is rendered freer and less congested, and at the same time the vital capacity of the lungs is increased.

A third method of employing compressed air is an air bath,

with arrangements by means of which the air upon the exterior of the body may be either compressed or rarefied, while the patient breathes air at normal pressure either saturated or not with medicinal vapours. It was Hawke who first applied this method to bring about increased thoracic movements in atelectasis, and other lung affections in children (Von Ziemssen's Handbook, vol. iii.).

Divers after working under a pressure of 2 to 3 atmospheres sometimes suffer from pain in the extremities and epigastrium (which may or may not be associated with nausea and vomiting), paralysis more or less extensive and complete, headache, vertigo and coma: sudden death may occur (Allbutt's System, vol. vii.). The symptoms may depend on the too sudden change of pressure, leading to air embolism, and particularly of bubbles of nitrogen (Bert), or more probably to changes in distribution of the blood, especially in closed cavities (A. H. Smith). These effects do not occur if the change be made gradually, and if severe they are relieved by a return to the compressed air. The condition described is known as Caisson Disease.

OZONE.—Ozone is an allotropic form of oxygen. Its discoverer, Professor Schönbein of Basle, did not arrive at a knowledge of its real nature, but Odling (in 1860), by a "splendid hypothesis," concluded it to be a *condensed* condition of oxygen, and this was afterwards verified, amongst other observers, by Brodie, who adopted the symbol O_3 , implying that three atoms of oxygen are condensed in each molecule of ozone. A minute proportion of it is found in the atmosphere—more in that of the open country and of the sea than in that of towns, but its precise distribution and variation are not yet ascertained. Richardson calculated its amount as 1 in 10,000 of air (Brit. Assoc. Rep., 1865).

Ozone is produced in small quantities during the slow oxidation of phosphorus, terpenes, and some other substances. Lender recommends for its evolution in sick chambers a mixture of peroxide of manganese, permanganate of potassium and oxalic acid, to be dissolved in water. In the laboratory it is prepared by passing a succession of electric shocks through a closed chamber filled with air, or by liberating a high tension current in a room and sending through it a current of air (Lancet, i., 1899). It develops under many outdoor conditions of air-currents, etc., thus damp linen exposed for some hours to a high wind and

brought indoors brings ozone with it, as shown by starch paper (Lancet, ii., 1897).

Ozone is much denser than oxygen, and in most chemical and physical, though not in all vital effects, it is more active; it is further distinguished by a peculiar odour—hence the name; it is a powerful oxidising agent, and changes many protosalts into persalts; it displaces iodine from some of its combinations, hence iodised starch paper is used as a test for the gas—the paper turns bluish as iodine is set free and combines with the starch, but the test is not very dependable.

According to Paul Bert, it possesses marked antiseptic properties, and animal substances keep long unputrefied in an atmosphere to which a minute proportion of ozone has been added (Med. Record, 1876; Comptes Rendus, t. 80), but the necessary amount of ozone cannot in practice be maintained in the air, and in any case its antiseptic action is only exerted on the surface of substances liable to putrefy.

PHYSIOLOGICAL ACTION.—Professors Dewar and McKendrick pointed out the remarkable fact that, instead of the blood becoming more highly oxygenated under ozone inhalations, it assumes venous characters in all the vessels, a fact which is explained by the greater density of this gas interfering with the due excretion of carbonic acid from the blood; it causes also some local irritation of the lining of the air-passages, with slowing of the heart's action and respiration,—probably reflex (Proc. Roy. Soc., 1873-74). After exposure to ozone, albumin undergoes a change, becoming uncoagulable by boiling and by acids (except in large quantities), and by the other reagents usually employed to precipitate it, with the exception of basic lead acetate, and of alcohol (Brunton). This change probably occurs also in the mucous membrane of the air-passages when the gas is breathed, and explains the irritation caused.

Dr. Ireland had previously stated that ozone *quickened* respiration and circulation, excited the nervous system, and promoted coagulation of blood (Edin. Med. Journ., 1862-63), but it is probable that his animals respired mainly oxygen. Dr. Day also had found that oxygen, “ozonised in proportion of one-twelfth, caused rapid respiration and heart-action, and much local irritation”; but Dr. John Barlow has confirmed and added to the

observations of Professors Dewar and McKendrick. He reports that ozonised air depresses the nervous system, probably through leading to accumulation of carbonic acid in the blood; it lessens the frequency of respiration, and hence also of the heart's action, together with the excretion of carbonic acid and the absorption of oxygen. It irritates the pulmonary and nasal mucous membrane, and may cause inflammation of the latter or bronchitis or lung-congestion (Redfern), or even asphyxia (Journ. Anat., Oct., 1879). According to Binz (Berl. klin. Woch., 1882-1884), ozone produces sleep and narcosis in animals; this, however, has been denied by Filipow (Arch. f. ges. Physiol., 1884, Bd. xxxiv.), who found that the gas caused marked irritation of the mucous membrane of the respiratory tract. The subject has been further investigated by Hugo-Schulz (Arch. f. Exper. Path. u. Pharm., 1892, Bd. xxix.), who found that the repeated inhalation of ozone for long periods produced excitement, dyspnœa, bronchitis and œdema in the lungs of animals.

It is possible that in these experiments the ozone contained impurities in the form of the oxides of nitrogen. Any such irritant effects may, however, be entirely obviated by dilution; thus Dr. A. Ransome reports that pure oxygen, ozonised to 9 or 11 per cent., may be freely inhaled without causing any inflammation (B. M. J., i., 1890).

It has been found poisonous to low organisms, such as bacteria, and is thus a powerful, if not a practicable, antiseptic. The latest experiments, however, show but little sterilising effect of currents of oxygen and ozone on bacteria—none at all on tubercle bacilli in sputum—but some on other bacilli when suspended in milk. "Any purifying action ozone may have in the economy of Nature, is due to the direct chemical oxidation of putrescible organic matter" (Ransome and Foulerton, abstract, B. M. J., i., 1901). It decolorises the red corpuscles, and causes a granular appearance, probably from uniting with hæmoglobin; it stops the amœboid movements of the white corpuscles, and renders the nucleus apparent; but there is no evidence of its entering the circulation in a free state. It is a physiological impossibility to take ozone into the blood through the lungs, and even were it possible, its presence there is incompatible with the continuance of the circulation (Dr. G. Thompson).

THERAPEUTICAL ACTION.—*External.*—**Ulceration.**—**Gangrene.**—Oxygen was applied in a jet to atonic scrofulous ulcers by M. Demarquay, without much advantage, but in cases of severe and extensive burn it has been of service (Record, 1884).

Dr. G. Stoker has found the continuous action of dilute oxygen applied in indiarubber bags to the skin to be of much value, presumably as a local stimulant. Under its use chronic ulcers of fifteen years' standing and wounds left by extensive burns take on a remarkably healing action. The new skin is soft, smooth, warm, not rigid, and almost indistinguishable from normal skin (B. M. J., i., ii., 1896, and Pamphlet). He has also found that the same application is useful in alopecia and some other conditions (Lancet, i., 1895; i., 1897). Gangrene has been attributed by M. Raynaud to deficient oxygenation of tissue, and Langier and other French surgeons have recorded good results from its local treatment by oxygen (Bulletin de Thérap., 1863-66). The destruction of tissue has been checked and limited, the swelling subdued, and the neighbouring threatened livid tissue restored to its natural colour (Goolden, Lancet, i., 1866, ii., 1870).

Tuberculous peritonitis sometimes gets better after laparotomy, apparently from exposure to air and light; it has been presumed that oxygen might act even better, and 1 to 2 litres have been injected in such cases and in ascites, due to cirrhosis of the liver, with benefit (B. M. J., ii., 1898, Ep.).

THERAPEUTICAL ACTION.—*Internal.*—**Inhalation.**—Pure fresh air of the elevated country or the coast is of well-known efficacy in all conditions of debility, of chronic catarrh and chronic dyspepsia. Sea air especially contains more ozone than inland air, and is of value to those who have lived in towns and followed sedentary occupations. On the other hand, patients with weak chests and readily congested lungs are better in a less rare and less ozonised atmosphere, since a large proportion of ozone may excite in them irritation of mucous membrane (Cornelius Fox). The chief cases in which theory indicates, and experience justifies, the use of oxygen-inhalation are those of asphyxia and of venous congestion occurring in the course of phthisis, pneumonia, asthma, emphysema, and other forms of lung or heart disease, and in these its use has become much more frequent since the last edition of this work.

Asphyxia.—When this condition is induced by breathing noxious gases, the best results are obtained from oxygen. Sometimes a free current of fresh air is sufficient to restore persons rendered unconscious by an escape of gas or by the products of combustion retained within a room; but in extreme cases pure oxygen would seem the only means of saving life. Limousin has reported a case of asphyxia from carbonic acid inhalation, with intense cyanosis, which recovered under the use of oxygen, and in which he was able to verify a steadily increased elimination of carbonic acid by the lung, in proportion to the oxygen taken (Compt. Rend. Soc. de Thérap., 1868). M. Constantin Paul has recorded many cases, including cyanosis from obstructed respiration, coma from opium-poisoning (when the respirations were only seven per minute), and asphyxia from carbonic oxide, all quickly and markedly relieved by oxygen (Bulletin de Thérap., Aug., 1868). Rabuteau refers to an instance of its good effect in asphyxia from sewer-gas, when ordinary means had failed to relieve; and a striking case has been reported by Dr. Charles B. Ball. A man, wife, and daughter were found unconscious in a small room where there had been, through the night, a large fire, though the chimney was blocked. The two adults recovered with fresh air and ordinary means, but the daughter, aged sixteen (phthisical), remained unconscious and convulsed. After many hours of stimulating treatment she seemed to be dying—respiration was feeble and slow, the pulse imperceptible—then she was made to inhale pure oxygen, afterwards oxygen and air. “The effects were rapid and marked,” respiration, colour, and pulse improved, and though at first convulsed, she ultimately recovered.

The combination of oxygen with nitrous oxide has been found to make its action both safer and pleasanter, cyanosis being often altogether absent during the anæsthesia (*v.* Nitrous Oxide), and Neudörfer, Kreutzman and others have spoken well of a mixture of oxygen with chloroform as an anæsthetic. It is claimed that it prevents vomiting, excitement and after-headache; that vomiting does not occur even if the patient has food in his stomach, and that consciousness is at once regained when the administration of the mixture is discontinued.

In various forms of poisoning whenever death threatens from asphyxia, as under prussic acid, chloroform, morphine, etc., artificial

respiration, *i.e.*, supplying more oxygen, offers the best means of saving life. Colonel Esdaille published a sensational case of oxygen-inhalation in coal-gas poisoning (Lancet, i., 1891), and others are recorded (B. M. J., ii., 1891, Ep., and Lancet, i., 1894; ii., 1895), but the results are not always so favourable. Dr. G. Thompson could trace no satisfactory result in blood-poisoning from diphtheria, or coal-gas, or in endocarditis, but much in bronchitis, pneumonia, etc., and wherever there was lessened surface for aeration of blood, especially in neurotic and uræmic dyspnœa (*loc. cit.*). Dr. Catlin also points out that if, with a limited lung-capacity, we can secure absorption of the same quantity of oxygen as in health, the result must be good, and describes it as a sure and satisfactory stimulant in cases of shock (Record, 1891), also in phosphorus poisoning (*cf.* p. 56).

Asthma.—Emphysema, etc.—The main suffering, the *besoin de respirer*, common to these maladies is traceable to deficient access of oxygen to the blood in the lung-capillaries, and relief may often be given by supplying a larger proportion of the gas. Dr. John Hooper thus describes its effects in a man of fifty-five, “for many years a martyr to asthma.” During a very severe paroxysm, the end of a glass retort containing oxygen was applied to his mouth, though he had not power to enclose it with his lips. “The effect was wonderful and quickly manifest in increased mobility of the ribs, fuller inspiration, disappearance of lividity, and lastly in his seizing the end of the retort, and in the avidity with which he inhaled when possessing the voluntary power” (B. M. J., i., 1862). Beddoes related twenty-two cases, of which he claimed to have cured ten and relieved nine; and it seems worth while to refer to his case of “Mr. Hare, of Conduit Street, who, in 1796, after having been subject for eleven years to asthmatic attacks accompanied by indescribable suffering, and only relieved after many hours by blisters and expectorants,” recovered average health under the use of the gas continued for some months (*op. cit.*, 4th part). M. Demarquay also witnessed excellent results, *e.g.*, in a man aged nineteen, subject from childhood to asthmatic attacks —“they ceased, as if by magic, as soon as he began to inhale oxygen” (Essai de Pneumatologie). Several cases of uræmic dyspnœa and coma are recorded in which the inhalation of oxygen gave great relief (Lancet, ii., 1895).

Dr. Mackey has reported (Pract., ii., 1869) the case of a lady, aged fifty-five, subject to constant dyspnœa, increased by movement, and amounting at times to partial asphyxia. She had advanced emphysema with dilated weak heart, embarrassed circulation, and œdema of the face and extremities; was subject to attacks of bronchitis, but at the time of treatment the main complaint was the difficulty of breathing. She inhaled a mixture of from three to twelve pints of oxygen, with sixty of air, at intervals of three or four days for a period of six weeks. After each dose "marked relief was experienced, which she expressed as being able to take a deep breath and get sufficient air (a feeling not known for years), as being able to move with comparative ease, feeling more buoyant and more like healthy persons should feel than she ever remembered."

According to Biedert's method, emphysema is treated by a few short sittings of respiration in *compressed air*, and then by expirations into an atmosphere of *rarefied air*, and at the Brompton Hospital, baths of compressed air which the patient inhales are frequently given in emphysema, and with better results than, perhaps, from any other treatment.

In **Bronchitis**, bronchial catarrh, and bronchial asthma, *compressed air* is used to stimulate the lung, improve its circulation, and facilitate expectoration—it seems to be useless during actual asthmatic attacks.

Pleuritic Effusion.—Empyema.—I have used oxygen in several of these cases with good results. During inhalation relief to breathing was experienced, which lasted for some time afterwards: compressed air has also been employed for these disorders. Biedert reports two cases of pleuritic adhesion in which vital capacity was much increased by it, and Kelemen one of empyema in which the effusion disappeared as diuresis set in (Med. Record, Aug., 1879). Williams' results in pleuritic cases are not so favourable (B. M. J., i., 1885). It is a method that might be employed with advantage until operation can be performed: Hale White has recorded a case of empyema rupturing into the lung, in which he considers that oxygen saved the life (*op. cit.*).

Whooping-Cough.—Moutard-Martin says that compressed-air baths are efficient in this complaint (Union Méd., 1879). Of 100 cases (children) recorded by Sandahl in Sweden, 88 were re-

ported cured by this treatment, the exceptions being those which were phthisical. Oertel confirms this experience. Inhalations of oxygen and ether are also valuable (*v. Preparations*).

Phthisis.—The value of oxygen inhalations in this disease has been the subject of much discussion. As early as 1783 it was tried with apparently good results, and Fourcroy was appointed by the French Government to report on the subject. After examining into twenty cases he concluded that almost all patients benefited, for a time at least, by the treatment, but relapsed and got worse more rapidly and with more inflammatory complication than if oxygen had not been used (*Sur les Propriétés Médicinales de l'Air Vital*, 1789). It is evident that to establish such a conclusion very careful observation is required, and more precision than the then art of diagnosis could attain; but the opinion exercised considerable influence at the time, was adopted by Dr. Beddoes and some other observers, and was one reason why this method of treatment fell into a disuse which was not altogether deserved. Albrecht reported good effects in cases of phthisis, the patients gaining weight, etc., under oxygen inhalation; inoculated animals also, subjected to inhalations, continued to live long after those not inhaling it had died (*L. M. Record*, 1883). Drs. Thorowgood, Neumann, and others have also reported relief to the dyspnœa of advanced phthisis, and Dr. A. Ransome, at the Manchester Hospital for Consumption, administered ozonised oxygen "to fifteen patients in all stages of the complaint, and results were very marked in procuring improvement in general health, better appetite, sounder sleep, freedom from fever, and consequent gain in weight" (*Medical Chron.*, 1889). It had no germicidal action, though the amount of expectoration was lessened.

The use of compressed and rarefied air seems rather to alleviate symptoms than to cure phthisis. In the pretubercular stages it serves to strengthen the respiratory muscles and open out the chest, but it is not suitable for acute or hæmorrhagic cases, or for those with a large area of congestion.

Open-Air Treatment of Consumption.—Although the idea of treating tuberculous diseases by an open-air life is by no means a new one, yet the systematic treatment of such diseases by spending night and day under shelter in the open air in all

weathers, conjoined with persistent good feeding and in pyrexia cases rest in bed, is comparatively an innovation. The best results, as would have been anticipated, are obtained in early or incipient cases, but, even advanced cases, with much cavity formation, may take on a definite and comparatively rapid healing action under the treatment. This treatment may be carried out in any suitable house with proper attention to ventilation and "perfect aseptic hygiene," but under constant medical supervision. It has become increasingly apparent that climate *per se* is of relatively small importance, in the treatment of consumption, in fact there are obvious advantages in treating, at any rate, the poorer members of the community thus afflicted in the climatic conditions under which they will have to live and work after their recovery. (Later experience has shown that the overfeeding which was formerly thought to be a most important part of the treatment is not only unnecessary in many cases, but may even be harmful; at any rate patients have frequently been observed to be putting on weight while the morbid process, as manifested it may be by the number of tubercle bacilli in the sputum, has been actually progressing.)

The same method may be very advantageously applied to tuberculosis of bones and glands and probably to many other quite distinct diseases. A modified form of open-air treatment, particularly that conducted in South Africa, has been giving very good results for at least thirty years back. An open-air life in the high lands of the Orange River Colony and the Transvaal has been the means of restoring many chronic consumptives to perfect health, and the same applies in a less degree to that lived in the Californian Alps. It is probable that in such a life the mental occupation is a useful factor in the recovery.

Pneumonia.—The experience of recent years during the numerous epidemics of influenza has shown that the inhalation of oxygen is sometimes of great service for the relief of the dyspnoea of pneumonia. It enables more oxygen to be taken up by the blood in the portions of the lung still available for respiration; it diminishes the frequency of respiration, and relieves the strain on a heart already overtaxed and weakened by the supply of impure blood (Lancet, i., 1891-92; B. M. J., i., 1896; ii., 1897; i., 1898). There is evidence also that resolution sometimes takes

place more rapidly after the use of oxygen, but such good results can by no means be depended upon.

In **Broncho-Pneumonia**, of which an unusual amount has followed the late epidemics of influenza, oxygen has again been largely used. A paper by Sir Lauder Brunton and Dr. Prichett (B. M. J., i., 1892) described a severe case with cyanosis, in which, after failure of venesection and strychnine, much improvement followed the use of this gas, which did not, however, prevent a fatal issue. Similar cases were reported by Drs. Allen, Gilchrist, M. Skerritt, Mr. Langston, and others, with more fortunate terminations by Dr. Beverley Robinson, Mr. Maughan, and Dr. Collier. My own experience has not been so favourable—no effect was produced in one case by a free stream for fifteen or twenty minutes, and the greatest objection was shown by the half-conscious patient to the oro-nasal inhaler, and in another case to the gas current from an open rubber tube. If this remedy is adopted it should be given a fair trial, and the use continued for several hours or even days (*v. p. 17*).

In **Cardiac Dyspnœa** due to mitral disease, especially when recurrent in the early morning, I have known oxygen inhalation give much relief. Mr. Blair and others have reported similar benefit in the cyanosis of such conditions (*cf. B. M. J.*, i., 1892). A large number of cases are recorded by Dr. A. H. Smith (New York Prize Essay), and his general results are favourable, and have since been amply corroborated (*cf. B. M. J.*, i., 1894). I would except from its use cases of acute character, and of hæmoptysis, in which, indeed, the mere exertion of inhaling would contraindicate it. In other cases benefit may be hoped for, not so much through any local action on the lung-tissue as by an improvement of the blood-condition, the appetite, and the power of assimilation; nor, speaking from experience, do I believe that oxygen, used with ordinary care, and in such dilution as has been mentioned, can irritate or inflame the lung-tissue. In anginal cases it may give great relief (B. M. J., ii., 1899; ii., 1900).

Chlorosis.—Anæmia.—Beddoes relates many instances of chlorosis benefited by inhalations, but other observers have not met with equal success from its use in this malady. I have, however, known it relieve chlorotic headache. Three cases of chlorosis benefited by oxygen after failure of iron are reported in

the New York Medical Journal, February, 1897; it was given diluted with nitrogen (Walton's compound) at half atmospheric pressure thrice daily. In leukæmia it has proved serviceable (L. M. Record, 1884); but in some extreme cases of anæmia the gas is not always well borne—it has sometimes increased depression for the time, and caused faintness and palpitation. Neumann, on the other hand, reports favourably; also Hayem, and it has been useful in hæmophilia (Lancet, ii., 1898). At an establishment in St. Raphael (Riviera) a specialty is made of the treatment of anæmia, debility, etc., by inhalation of ozonised air, as well as baths, etc., and some good results are reported. The inspiration of condensed air has been found a useful adjuvant to other remedies.

Diabetes.—Pettenkofer and Voit concluded that diabetics absorbed less oxygen than healthy persons, and hence we might hope, by introducing more into the system, to obviate some conditions of the malady.

Bouchardat, and also Demarquay, have recorded cases relieved by this treatment, but no extensive trial of it has been made. Peroxide of hydrogen has been given internally with the same object. I have tried oxygen inhalation in several cases of diabetes in which prostration, dyspnœa, and a tendency to cyanosis were prominent symptoms—one case was at the very unusual age of seventeen months, another at thirteen years, and three others at adult age. The gas relieved for a time the symptoms, although it did not in any instance reduce the sugar in the urine. It was especially useful during the coma. Dr. E. Morin reported favourably (in a prize essay before the Medical Society of Antwerp) of daily oxygen inhalations for diabetes.

Albuminuria.—In a few cases of Bright's disease narrated by Dr. C. Paul, albumin disappeared from the urine during treatment by oxygen. This occurred also in the often-quoted case observed by Kollmann and Eckart (Schmidt, Jahrb., 1865). Dujardin-Beaumetz reported a case "in the last stage," in which every diuretic had proved useless, and yet twenty-four hours after inhaling oxygen the albumin disappeared, and was still absent twelve days afterwards (Med. Record, 1879). Other physicians, whilst recording similar cases in their own experience, have stated that the good result was not of long duration. Jaccoud observes

that if albuminuric cases do not show marked improvement under his ordinary treatment of milk diet and cold douches, his next resource is always inhalation of oxygen—thirty litres daily, at three or four sittings (*Med. Times*, i., 1885).

Tetanus.—Strychnine Poisoning.—Richardson refers to some cases of tetanus, under Sir J. Paget, relieved by oxygen inhalation: the patients became bathed in perspiration, and the muscles relaxed. He insists also on its importance in strychnine poisoning in conjunction with amyl nitrite: as unless elimination be promoted by oxygen the spasm, even if relieved, soon returns.

The argument for the use of oxygen in these cases is that the muscular contractions involve a large consumption of it, and this, together with the defective respiration, renders the supply of oxygen to the nervous and other tissues insufficient; at the same time an anæsthetic should be given to diminish the abnormal activity of the nerve cells.

Rosenthal and Leube found that the symptoms of strychnine poisoning might be deferred or prevented by artificial respiration (*Reichert's Archiv*, 1867). H. Ebner thought the same result could be obtained by rhythmical movements of the limbs without supplying more air to the lungs, but Ananoff has since proved that pure oxygen is distinctly antagonistic to strychnine, and that when supplied to animals poisoned by this alkaloid it relieves them more than free access of ordinary air, or any movements (*Cbl. f. med. Wiss.*, 1874). In narcotic poisoning, drowning, and still-birth, a method of performing tracheotomy and then allowing a full stream of the compressed gas to flow into the lungs has been found of service in resuscitating apparently moribund persons after the ordinary methods of artificial respiration had failed (*G. Foy, Med. Press*, March, 1894; *G. E. Fell, Canada Med. Rec.*, Jan., 1894).

Paralysis of Divers.—When divers are submerged at a considerable depth, the high pressure causes both the nitrogen and oxygen of the air to be absorbed into the blood. On coming to the surface, the nitrogen being set free, gaseous emboli may be formed. Bert found in animals with this condition that the normal state of the blood was restored by the inhalation of oxygen, as nitrogen diffuses as rapidly into an atmosphere of oxygen as into a vacuum: he therefore strongly recommends it in this form of paralysis (*cf. p. 5*).

Dose and Mode of Administration.—The Central and also the Brin Oxygen Co.¹ supply iron cylinders of various sizes containing the compressed gas, which in urgent cases may be administered through the mouth or nose from a tube connected with a suitable funnel. It may be, and generally should be, warmed by laying the tube partly in hot water, or by a suitable apparatus (*Lancet*, i., 1899; *B. M. J.*, ii., 1897). The dose may be varied according to the effect, but from half to one gallon every half-hour, continued for three to four days, has been used (*Chambers*, *Lancet*, i., 1890). In chronic maladies an inhalation of the gas, preferably diluted with half or two-thirds of air or one-third of nitrogen, should be practised for about half an hour once or twice with slow, deep inspirations, about one minute between each. As this requires an effort for some patients, they should be quiet for a time before and after, not overfatigued, and the stomach should not be full or quite empty; the feet should be warm and the circulation equable. Dr. Valenzuela (Madrid) has given the gas readily per rectum, as much as five litres being absorbed four times in an hour, and states that dyspnoea may be relieved in this manner when attempts at inhalation fail. Under the skin, also, from half to one litre may be introduced at a time, with marked stimulating effect on the heart (*Lancet*, 1891). Dr. W. Ewart has injected it in the form of hydrogen peroxide. Laudi has passed it directly into the stomach through water previously injected; Laborde has given it by intravenous injection (*Comptes Rendus*, 1885), Kollogg and Humphrey by enemata (*Med. Age*, April, 1888), and, as already mentioned, it has been injected into the peritoneum.

Other modes have been devised for introducing oxygen into the system, as by oxygenated water, which may have a limited sphere of usefulness: Bert has stated that it destroys the bacilli of anthrax (*v.* Hydrogen Peroxide, Chlorate and Permanganate of Potassium).

Contra-Indications.—I have not met with any case in which oxygen, more or less diluted, could not be safely used. If organic heart-disease be present, care should be taken to regulate the force

¹Cylinders of compressed oxygen can be obtained from the Central Oxygen Works, Sheffield Street, Lincoln's Inn Fields, and from Brin, Horseferry Road, London; also through most chemists.

and the effort of inhaling, which sometimes gives rise to giddiness or palpitation independent of the remedy. Soreness of the throat and temporary discomfort about the mouth may occur if the apparatus be not quite free from dust, but from the gas I have seen no bad results. Indications against the use of compressed air are degeneration of vessels and an apoplectic tendency; against that of rarefied air, pulmonary hæmorrhage.

NITROGEN, $N = 14$ (13.94). *Not Official.*

This gas is very widely diffused, constituting 76.99 per cent. by weight of the atmosphere, 79.19 per cent. by measure. It exists in several combinations with oxygen, some of which act as acids, and give rise to nitrates and nitrites. From atmospheric nitrogen Ramsay and Rayleigh have isolated the new element Argon, and other bodies.

CHARACTERS.—A colourless, odourless gas, sp. gr. 0.975; it is soluble in fifty times its volume of water. It is liquefied by pressure and cold, and boils at -213°C .

PHYSIOLOGICAL ACTION.—This is negative in character; the gas will not support respiration or combustion, and it seems in the atmosphere to serve the purpose of a diluting agent and thus diminish the intensity of oxidation. The blood contains about 1.5 per cent. volume of nitrogen, present in solution. There is no evidence that nitrogen plays an active part in respiration; only the lowest forms of life, such as some bacteria, appear to be able to fix the nitrogen of the atmosphere. An animal confined in nitrogen dies from want of oxygen.

THERAPEUTICAL ACTION.—Inhalations of nitrogen have been tried in some diseases of the lungs, but the results are indefinite. It has also been injected into the pleural cavity to produce pneumothorax and allow of the collapse and rest of the lung in tuberculosis.

NITROUS OXIDE.

NITROGEN MONOXIDE ($\text{N}_2\text{O} = 44$).

Nitrous Oxide was formerly called "laughing gas," and is now commonly known as "gas."

CHARACTERS.—A colourless gas, almost without odour, but with a sweetish taste. The presence of red fumes in the gas, or irritant effect during respiration, shows contamination with nitric peroxide (NO_2). It supports combustion when a glowing match is plunged into it. It is very soluble in water, which will dissolve more than its own volume of the gas. It is heavy, specific gravity 1.527, so that when placed in an open vessel it diffuses very slowly. At 45°F . it is liquefied by a pressure of forty atmospheres, and is now supplied for anæsthetic purposes in a liquid state in iron cylinders generally holding the equivalent of fifty or a hundred gallons of gas. It can be decomposed at a high temperature, such as that of glowing wood, but not at the temperature of the body; it cannot, therefore, give oxygen to the tissues, as Davy thought.

PHYSIOLOGICAL ACTION.—On inhaling the gas there is at first some sense of warmth, with a feeling of pressure and fulness in the head and ears. Formerly, probably owing to the presence of impurities, stimulant effects were very marked, as shown by laughing, excited talking, etc. Hysterical symptoms, with screaming and crying rather than laughter, sometimes developed, and headache and sickness occasionally followed, but now, as a rule, the gas may be inhaled to complete anæsthesia without unpleasant effects. As the gas enters the circulation the skin becomes livid, and in thirty to sixty seconds the conjunctivæ are insensible, the muscles, which at first may be contracted, relax, the pulse is generally *quickened* and weakened,¹ and when anæsthesia is complete the breathing is commonly stertorous, and convulsive twitchings of the muscles occur.

¹ This is probably the usual effect in practice, but though Thomas asserts it, Turnbull says "the pulse always *decreases* when the patient has begun to inhale" (Anæsthesia, 2nd ed., p. 179). Wood and Cerna state that under the pure gas the pulse rate is *slowed*, and the blood pressure greatly raised.

Some authors have ascribed the early acceleration of the pulse to a depressant action on the cardio-inhibitory centres and not to stimulation of the higher cerebral centres. The subsequent slowing of the pulse, with rise in its tension, is a part of asphyxia.

This is also a probable explanation of some cases of temporary glycosuria occurring after administration of nitrous oxide to men and dogs. A few deaths have been recorded, perhaps six out of millions of administrations, and the cause of these is doubtful; but some have occurred from accidental complications, such as pressure of the face piece (B. M. J., i., 1893); tight lacing, producing syncope (Lancet, i., 1895); or foreign bodies in the larynx; several have occurred after gas and ether (*ib.*, i., 1896-97) in which it was assumed, but not proved, that the gas had induced cardiac depression; in one, after gas with oxygen, and then chloroform, it was presumed to dispose to cardiac dilatation; this was probably due to the action of the chloroform. Dr. Hewitt remarks that the pure gas tends to produce some degree of obstructed breathing from spasm of the muscles at the upper opening of the larynx, and becomes, therefore, more dangerous when any obstruction already exists, but this is doubted by other observers.

THERAPEUTICAL USE.—MODE OF ADMINISTRATION.—Nitrous oxide is used mainly for the production of anæsthesia for short operations, especially in dentistry, but since the method of combining it with air or oxygen has been more generally adopted, its effect has sometimes been prolonged for an hour or more, whilst major operations have been performed (Paterson, Lancet, i., 1899). But the patient is then as much upset as with ether and chloroform, and, as upwards of fifty gallons of the gas with seven or eight of oxygen must be allowed for every quarter of an hour (Gardner), and expense and convenience have to be considered, the method is rarely employed. It is very usual to begin with the gas and continue with ether or chloroform.

The pure gas unmixed with air is still commonly used—it should be fresh as well as pure; the patient's clothing should be loose, a suitable inhaler applied over the mouth and nose so as to prevent escape of the gas rather than to keep out a little air, and slow, full inspirations directed to be taken till the symptoms already described appear. This may be in forty to sixty seconds, but when the gas is not delivered under much pressure, or if a

valve be defective, or respiration is shallow and feeble, from one to two minutes may be required.

The time necessary for the production and the duration of anæsthesia varies; the Committee of the Odontological Society give seventy-three seconds for the former and twenty-five for the latter, Dr. Hewitt fifty-one seconds and thirty-five, Dr. Dudley Buxton fifty-five seconds and thirty-five seconds respectively. In operations upon the mouth the anæsthesia can be maintained by the administration of the gas through a metal tube which is inserted into the mouth (Coxon), or by a nasal tube (Hilliard, Coleman).

The gas has also been administered with some effect in neuralgia, hysterical aphonia, and in spasmodic asthma. In epilepsy, when independent of organic changes, it has been recommended for use three or four times a week.

Childbirth.—Perhaps a more important, though, as yet, scarcely practicable, application of nitrous oxide with oxygen is to safely relieve the pains of childbirth.

Zweifel at Erlangen, and several physicians in Russia, have had constructed chambers (after Bert's model) in which 20 per cent. of oxygen has been mixed with 80 per cent. of nitrous oxide, and in which parturient women have been placed. In sixty cases all has gone well; the process has not been retarded, and the women have been free from pain and yet not unconscious (B. M. J., ii., 1885; *cf.* Van Arsdale, *loc. cit.*).

There are no special contra-indications to its use, especially now that asphyxial symptoms can be lessened or prevented by oxygen; it has been safely given in many forms of cardiac and pulmonary disorder, though it is desirable sometimes to give strychnine or other cardiac tonics beforehand. Drawing forward the tongue, fresh air and artificial respiration, posture and the ordinary treatment of syncope may be required in the presence of danger, and quiet should be maintained for some minutes after recovery. In Dr. Silk's cases, 12 per cent. complained of surface itching, 2 per cent. had asphyxial symptoms, several were hysterical, but 70 per cent. had no trouble; sexual illusions occurred in six cases. Epileptics and nine cases of pregnancy did well, one of valvular heart disease showed a tendency to syncope.

For further details as to nitrous oxide, reference may be made

to Dr. Dudley Buxton's "Anæsthetics, Their Uses and Administrations," and Dr. Hewitt's work, "The Administration of Nitrous Oxide and Oxygen for Dental Operations."

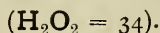
HYDROGEN, $H = 1$. *Not Official.*

Hydrogen, being the lightest of known elements, is commonly taken as a standard of specific gravity and combining proportion. It has been found free in small proportions in certain volcanic gases, and occurs extensively in combination, *e.g.*, in water, in many acids and gases, in hydrocarbons, and all substances used for artificial light—tallow, oils, coal gas, etc.—and throughout the vegetable kingdom. It has recently been shown by Gautier to be a normal constituent of the atmosphere, in the proportion of 2 volumes in 10,000, and Dewar and Liveing have made a similar observation (*Ann. de Chim. et de Phys.*, Jan., 1901; *B. M. J.*, i., 1901). It was formerly known as "inflammable air," and, when lighted, burns with a bluish flame. It has been liquefied by Dewar, and then boils at 240° C. below zero, and freezes solid a confined space of air (*B. M. J.*, i., 1898). It has also itself been frozen solid, and then appears as a white froth-like mass (Dewar, *Lancet*, ii., 1899).

CHARACTERS.—A colourless, inodorous gas, of sp. gr. 0.0692. It combines readily with arsenic, sulphur, etc.

PHYSIOLOGICAL ACTION.—This is negative in character. Hydrogen does not support respiration or combustion, and animals immersed in it die as soon as in nitrogen. Attempts to inhale it cause cyanosis of the lips and face, quickness and smallness of the pulse, vertigo, impaired vision, and in some persons drowsiness, slight insensibility, and, when pushed, asphyxia in greater or less degree. A mixture with oxygen, when inhaled, causes the voice to become shrill.

THERAPEUTICAL ACTION.—Dr. Beddoes used hydrogen gas as an inhalation in phthisis, both by itself and in mixture with oxygen. He reported some cases as relieved and others cured, but his results have not been corroborated. The most constant effect seems to have been the production of sleep.

HYDROGENII PEROXIDUM—PEROXIDE OF HYDROGEN.

CHARACTERS.—It is a liquid of syrupy consistence, nearly free from odour, but of a strong, disagreeable, metallic taste, very unstable and readily parting with its oxygen, especially on contact with a metallic oxide, such as manganese, silver, etc.; hence it is a powerful oxidiser and disinfectant. Derived from oxidised turpentine, it is the active ingredient in “Sanitas”. It bleaches litmus, and a solution of sp. gr. 1006 is in common use abroad for bleaching purposes. Its solution in ether is more stable, and is known as ozonic ether.

PHYSIOLOGICAL ACTION.—*External.*—Applied locally, it whitens the skin and mucous membranes, and acts as a moderate caustic; it has also marked antiseptic power. Urine mixed with one-tenth of peroxide remained nine months without putrefying (Guttmann).

PHYSIOLOGICAL ACTION.—*Internal.*—It produces, when given internally, stimulating, and in full doses irritant, effects. The bleaching solution, of sp. gr. 1006, has been used by Assmuth, Schmidt and Guttmann for hypodermic injection in animals, and was found to cause dyspnœa, clonic convulsions, and death in a few minutes from asphyxia. The last-named observer traces this to the development of bubbles of gas in the right cavities of the heart, the blood frothing up as if air entered by the veins. The result is partially antagonised by injection of ferrous sulphate, implying the combination of this with part of the oxygen liberated (Virchow's Archiv, 73, 1878).

THERAPEUTICAL ACTION.—*External.*—**Ulcerations.**—Lotions containing peroxide, 2 per cent. and upwards, have been used with advantage in soft chancre, in cases of fœtid ulcerations of the mouth, otorrhœa, etc., and in diphtheria as spray or gargle (B. M. J., E., i., 1894). In scarlatina, ozonic ether has been used by inunction as an antiseptic ointment, 1 dr. to 1 oz. of benzoated zinc ointment, and it is said to be effective in preventing infection. Owing to its oxidising powers it is a good antiseptic and germicide: in contact with pus or blood it decomposes with effervescence (Pract., xxxii., xl., lii.).

THERAPEUTICAL ACTION.—*Internal.*—**Chronic Dyspepsia.**—Richardson, Guttmann and others have reported im-

provement of digestion under this remedy, but it is not much used; drachm doses before meals have been given (B. M. J., E., ii. 1892).

Diabetes.—Cases of this disorder treated successfully by peroxide of hydrogen have been recorded and much good was at one time expected from it as an oxidising agent; but Sir B. W. Richardson, who introduced the remedy, and used it in more than two hundred cases, came to the conclusion that although it could reduce the sp. gr. of the urine, it, at the same time, increased its quantity, and had no really good effect (Med. Times, ii., 1868). In a later paper he attributed much more value to it, especially in combination with codeine, also in phthisis, syphilis and pertussis (Lancet, i., 1891). Dr. Pavy tried it in a few cases without any result (On Diabetes).

Cyanosis.—Pulmonary Congestion.—In these conditions, where oxygenation of the blood is defective, and which are generally connected with heart-disease, I have sometimes seen advantage from the internal use of peroxide of hydrogen—it is worth trial, but further observations are needed for estimating its true powers. Sir Walter Foster has reported two cases of congenital cyanosis relieved by it (Clinical Medicine, 1874).

Inflammation of Mucous Membranes.—Its use has been suggested in many inflammatory and purulent affections of the mucous membrane. Such as ophthalmia, otorrhœa, gonorrhœa, ozœna, and diphtheria; also as a wash for the stomach and bladder. Dr. W. A. Dayton finds that a 4 per cent. solution is a good cleanser in cases of otitis; it renders easy examination of such cases with the speculum, and cocaine acts better after its use (Practitioner, ii., 1885). Dr. Sexton also speaks highly of the same remedy in such cases (Record, 1885). M. Landolt uses it largely in ophthalmic practice, with success (Arch. d'Ophth., t. ii.).

Pertussis.—Much power has been claimed for peroxide of hydrogen in the relief of paroxysms of whooping-cough, but I have no experience of it. In a severe case, complicated with cyanosis, in a child with patent foramen ovale, Dr. Mackey used the remedy with apparently good result for the time: the degree of cyanosis was less whilst the remedy was taken, and the attack of pertussis ran a mild course.

PREPARATIONS AND DOSE.—Liquor Hydrogenii peroxidi (Official) is a solution in water containing 10 volumes of oxygen; ozonic ether contains peroxide in 30 volume strength in solution. Dose: of the former $\frac{1}{2}$ to 2 dr. freely diluted; of the latter solution $\frac{1}{2}$ to 2 dr. For local use, a 4 to 10 or 15 per cent. solution (which may be diluted), or ointment, or inhalation.

A preparation called "Lozone" is an aqueous solution of peroxide, obtained by oxidation of terpenes and containing half a volume, *i.e.*, a volume of the liquid can supply $\frac{1}{2}$ a vol. of nascent oxygen. "Eau de Maiche" (Paris), also colourless, represents three times its volume of oxygen. "Oxydol" is another solution (Lancet, *i.*, 1900), and "Menthoxol" one of 3 per cent. with menthol (Lancet, *i.*, 1898). "Pyrozone" is an American name for solutions of the peroxide—3 and 5 per cent., and as a caustic, 25 per cent. Peroxide of Sodium is a white deliquescent powder which gives rise to heat and parts with oxygen as it dissolves in water. Ether with oxygen may be obtained for inhalation, *e.g.*, in pertussis—by putting 2 oz. ozonic ether in a Wolff's bottle and adding 8 grains of permanganate of potash (dissolved in an ounce of water), and arranging on one opening a suitable inhaling tube. Peroxine is a colourless liquid with an agreeable smell, capable of yielding nearly twice its volume of oxygen, and containing nearly 1 per cent. of an essential oil which has become oxygenated during the course of manufacture.¹ Peroxine lotion is a stronger preparation, containing 5 per cent. of oxygenated essential oil and yielding nearly ten times its volume of oxygen. Peroxine ointment contains an oxygenated essential oil (Lancet, 5th Jan., 1901).

SULPHURETTED HYDROGEN—HYDROGEN SULPHIDE (H_2S = 34). *Not Official.*

CHARACTERS.—A transparent, colourless gas of offensive odour (like bad eggs), about $\frac{1}{5}$ heavier than air. It is inflammable, burning with a pale bluish flame, and is readily decomposed, sulphur being deposited. It is found free in nature in many mineral waters, in the emanations from volcanoes, as a product of the decay of albuminous substances, and of the decomposition of metallic sulphides. It precipitates metals from acid solutions, and hence is in frequent use as a test. Water absorbs about three times its volume of the gas, the solution being feebly acid.

PHYSIOLOGICAL ACTION.—This gas has antiseptic and germicide powers; it is highly poisonous to animal life when concentrated, and even when diluted with 600 to 1200 times its volume of air it is fatal to the lower animals and to plants. Brouardel and Loye gavé proportions of 2 per cent. and $\frac{1}{2}$ per cent. with air to tracheotomised dogs, death occurring in three minutes under the

¹ Introduced by the New Refining Company, 8 Princes Street, E.C.

stronger, and in seventeen to fifty minutes under the weaker mixture. The former was presumed to kill by paralysis of nerve centres, the latter partly by asphyxia; the pupils dilated and the conjunctivæ became insensible, the respiratory movements ceased for a time, but recommenced before death.

The gas has a destructive effect on the blood corpuscles, but the blood coagulates readily, and is found still to contain oxygen; its colour seen in thin layers is violet (*Abst. Amer. International Journ.*, 1886). The physiological action of sulphuretted hydrogen has a resemblance to that of hydrocyanic acid, but in fatal cases, which are most likely to occur from exposure to the confined gases of decaying animal matter, there are generally muscular tremors and frequently convulsion.

Extreme general depression, as well as local distension, has been connected with absorption of an unusual amount of the gas formed in the intestine. Dr. Schulz describes a soporific effect in animals confined under a bell-jar with definite proportions of the gas.

THERAPEUTICAL ACTION.—**Phthisis, etc.**—Mineral waters containing sulphides and sulphuretted hydrogen have long been used by inhalation and vapour, as well as by the stomach, in diseases of the respiratory tract (*v. Sulphur Waters*). Dr. Bergeon of Lyons some years ago introduced a method of treating pulmonary tuberculosis by injection into the rectum of gaseous sulphuretted hydrogen diluted with carbonic acid. The gas is absorbed into the blood and excreted through the pulmonary mucous membrane. About 4 litres of carbonic acid mixed with 100 cubic centimetres of sulphuretted hydrogen, or an equivalent of natural sulphur water, were injected once or twice daily. Although good effects were reported from this treatment, and it attracted much attention, yet further trials showed that it has no real value. Dr. Coghill spoke of it as “the greatest advance ever made in the therapeutics of pulmonary disease” (*B. M. J.*, ii., 1886), and Dr. Burney Yeo and others reported some good results, but he considers it now “discredited” (*Manual*, 1897).

Chronic Bronchitis.—**Chronic Rheumatism.**—The waters already referred to, as Barèges, Aix, Harrogate, etc., are of well-known value in these diseases, applied locally in spray or bath, as well as taken internally.

ANTIDOTES.—Chlorine cautiously inhaled—artificial respiration.

CARBO, CHARCOAL, $C = 12$ (11·91).

Carbon is very widely distributed throughout all the kingdoms of nature. The *diamond* represents its purest condition; *plumbago*, or *graphite*, the "black lead" of our pencils, is another form which is nearly pure, and is sometimes crystalline. *Charcoal* is a third allotropic modification, non-crystalline. In the form of carbonic acid gas (CO_2) it occurs in the air and in many mineral waters, while as carbonates, such as limestone, it is very widely distributed over the earth's surface. Another compound with oxygen, carbon monoxide (CO), is a highly poisonous gas, and is formed to a certain extent during the combustion of charcoal; it does not form salts.

CARBO LIGNI—WOOD CHARCOAL.

CHARACTERS.—Wood charcoal occurs as a black powder, without odour or taste, or in black brittle pieces, very light and porous, and retaining the shape and texture of the original wood. It is distinguished from purified animal charcoal by leaving 1 or 2 per cent. of mineral ash, and by not sinking so readily in water. It absorbs oxygen freely and is used as a deoxidising agent, *e.g.*, in the preparation of sulphurous from sulphuric acid (by distilling the latter with it), and the reduction of iodate to iodide of potassium.

CARBO ANIMALIS PURIFICATUS—PURIFIED ANIMAL CHARCOAL. *Not Off.*

CHARACTERS.—It occurs as a smooth, black powder, which has no odour and scarcely any taste, but possesses certain chemical and mechanical properties which are very useful in pharmacy. It is used as a decoloriser in the preparation of alkaloids, *etc.*; its power in this respect is such that diluted tincture of litmus will filter through it colourless. Warrington ascertained that it would remove the bitterness of hops and other vegetable infusions, and Sir Alfred Garrod soon afterwards pointed out that it would destroy the activity of many organic poisons, as opium, aconite, and nuxvomica, by absorbing them (*Lancet*, ii., 1845).

Animal charcoal is much more powerful as an antidote in this way than that prepared from wood. Both varieties possess great absorptive power, taking up many times their volume of gases (the amount varies with different gases), and may be used for purifying water by filtration, for the absorption of sewer emanations, and the deodorising of sick rooms, dissecting rooms, *etc.* A respirator containing a layer of charcoal has been recommended as a protective against poisonous gases (Stenhouse, Marcet).

THERAPEUTICAL ACTION.—*External.*—**Fætid Discharges.**—Charcoal is used in surgery to cleanse and alter the condition of old and sloughing ulcers, suppurating sores and wounds, and is sometimes applied directly to them in the form of powder, or poultice with bread; to relieve offensive odours it is better enclosed dry in muslin bags and placed over the wounds. For offensive perspiration of the feet or axillæ, charcoal may be mixed with alum or zinc oxide and used as a dusting powder, but although an efficient, it is not a very elegant application. Alone or mixed with chalk it forms a cleansing dentifrice: it removes offensive odours if present, and is said to preserve the teeth by absorbing acids, but its coarse particles tend to scratch the enamel. Charcoal “pegs,” made up with potassium nitrate, have been used as a cautery (Lancet, ii., 1866).

THERAPEUTICAL ACTION.—*Internal.*—For ordinary medicinal use wood charcoal is commonly preferred.

Dyspepsia, Flatulence, etc.—It is very useful for patients suffering from pain, weight, and sense of fulness at the epigastrium, with flatulent distension, acidity, sour or bitter eructations, nausea or vomiting, furred tongue, foul breath, and with a tendency to loose, ill-formed motions. These stomach symptoms are usually accompanied with palpitation.

The charcoal powder may act by causing oxidation and absorption of the offensive products of fermentation, but probably much of its good effect is due to a mechanical action. It should be perfectly fresh and taken dry, preferably at the commencement of a meal. The dose need not be so large as a teaspoonful, which is commonly given; in many cases I have found 20 gr. sufficient. The tincture of *nux vomica*, in 5 m. doses, or subnitrate of bismuth and magnesia, of each about 10 gr., are sometimes advisable at the same time.

Diarrhœa.—Charcoal acts well in the diarrhœa of scrofulous children when the stools are small, slimy, and light-coloured, with intermediate troublesome discharge of flatus and itching of the anus; also when the attacks have depended on irritation of the mucous membrane from undigested food, etc.: it may be well given with milk (Record, March, 1881). Rhubarb is often usefully combined with it. Charcoal is also serviceable in the atonic irritative diarrhœa of old people, but intestinal hæmorrhage may

occur after its use. If large quantities be given, some may be retained, and act as a mechanical irritant, so that the remedy is not so innocent as is commonly thought.

Dysentery.—Charcoal has been recommended in dysentery, and its antiseptic powers may be serviceable in chronic cases. The putrid smell of the discharges may be relieved by a few doses of 30 to 60 gr., but it returns on discontinuance of the remedy—the effect being a temporary chemical one. Dr. Farre has reported cases in which it has acted well when given in enema (Ranking, ii., 1862).

In **Enteric Fever** charcoal lessens the distension of the stomach and intestines, and mixed with magnesia it sometimes proves more beneficial; here also there is some risk of its causing hæmorrhage.

Cancer of Stomach.—**Gastric Ulcer.**—In these organic diseases many of the distressing symptoms, such as flatulence, vomiting and pain, may be relieved by charcoal.

Ascarides.—A daily dose of a mixture of charcoal and salt (a teaspoonful), given early in the morning, has been found useful in destroying and preventing the development of these parasites.

PREPARATIONS AND DOSE.—*Of wood charcoal* many varieties are in use, some practitioners giving the preference to that made from heavy woods (box, acacia, etc.), others to the light woods (poplar or willow). Dr. A. Leared recommended that made from “vegetable ivory.” Charcoal from the *hæmatoxylon campechianum* is good, but has been overpraised. Biscuits and lozenges of charcoal are used, but are not so effective as the powder; they sometimes irritate the stomach. *Carbo ligni*: dose, as an indirect antacid, anti-septic, or absorbent, 60 to 120 gr. or more. Gelatine capsules each containing 4 gr. of charcoal, and compressed tabloids are also in use: Tissot’s naphtholated charcoal, prepared with gluten in pellets, is a good form.

SULPHUR, S = 32 (31·82).

This element occurs in the animal kingdom as a constituent of the albuminous (proteid) tissues, of bile, of cystin, etc., in vegetable proteids, in many essential oils, such as those of mustard, horse-radish, garlic, and in resins, as asafœtida. In volcanic districts it is found native, and in many places it is met in combination with metals as sulphides (copper and iron pyrites). United with hydrogen, as sulphuretted hydrogen (H_2S), or in the

form of sulphides of the alkalies, it is found in many organic substances, especially during putrefaction, and in many mineral waters. With oxygen it forms sulphur dioxide (SO_2), the salts of which are called sulphites, and sulphur trioxide (SO_3), the salts of which are called sulphates.

CHARACTERS AND TESTS.—Sulphur occurs in commerce either as a gritty powder, or in round sticks (roll sulphur—brimstone), or in crystals; it is opaque and brittle, pale yellow in colour and tasteless, but emitting a peculiar odour if it be rubbed; it is inflammable, burning with a bluish flame and evolution of sulphur dioxide. It melts at 115°F. ; at greater heat becomes amber-coloured, then brown, and gradually thickens until the containing vessel may be inverted without spilling it; is insoluble in water, slightly soluble in alcohol (absolute alcohol dissolves nearly 1 per cent.), in fixed and volatile oils, and bisulphide of carbon. Hydrochloric acid added to sulphur or its compounds causes evolution of sulphuretted hydrogen.

SULPHUR SUBLIMATUM—SUBLIMED SULPHUR—FLOWERS OF SULPHUR.

CHARACTERS.—Sublimed sulphur is a gritty powder, canary-yellow in colour, and possessing the characters of the element as already described. It may be acid in reaction from the presence of small quantities of sulphurous and sulphuric acids formed by slow oxidation, and should be freed from these by washing with distilled water, when it is known as "sulphur lotum."

SULPHUR PRÆCIPITATUM—PRECIPITATED SULPHUR.

Called also *lac sulphuris* (milk of sulphur), though this name was originally given to an old preparation containing calcium sulphate.

CHARACTERS.—A pure specimen is of pale yellow colour, without odour or taste, very smooth to the touch, not readily diffused in water, but under the microscope it presents opaque rounded granules, separate or in clusters.

POTASSA SULPHURATA—SULPHURATED POTASH—HEPAR SULPHURIS.

CHARACTERS AND TESTS.—From its liver colour it was formerly called "liver of sulphur," but it rapidly absorbs oxygen from the air and becomes green and then dull white, sulphate of potassium being formed: it has an acid taste but alkaline reaction. It evolves sulphuretted hydrogen on the addition of any acid.

*CALX SULPHURATA—SULPHURATED LIME—CALCII
SULPHIDUM.*

CHARACTERS AND TESTS.—A nearly white powder, smelling of sulphuretted hydrogen, sparingly soluble in water. It should not contain much less than 50 per cent. calcium sulphide (CaS), the remainder being unreduced calcium sulphate.

ABSORPTION AND ELIMINATION.—It has been stated, though not proved, that finely divided sulphur may pass as such into the blood. Eberhard has seen it in the lymphatics, and Griffith has found it excreted in the urine, but these statements lack confirmation, and are not easy of credence.

It is more probable that, before absorption, under the influence of alkaline saliva and mucus, and the secretion of intestinal glands, alkaline sulphides are formed, part of which become decomposed in the intestine into sulphuretted hydrogen, and part oxidised, since the administration of sulphur increases the urinary sulphates (Regensburger, *Cbl. f. med. Wiss.*, 1877). Of any ordinary dose of sulphur a certain proportion passes out unchanged and unabsorbed in the fæces. Fatty substances are said to promote absorption of sulphur, though the experiments of A. Krause (1853) scarcely support this view. He found that when equal doses of sulphur were given either with or without fat, the amount of sulphates excreted by the urine was the same.

The sulphuretted hydrogen after absorption is eliminated by the skin, the bronchial mucous membrane, the lungs, and by the various glands, giving indication of its presence by its odour and by staining silver articles worn about the person. Orfila detected it in the urine. In exceptional cases the gas may be absorbed from the intestine with production of marked but temporary nervous depression, and one case of death has been recorded from this cause. In aged persons, and in some cases of hepatic and intestinal disorder, I have noticed attacks of depression coincident with flatulence and foul breath, and relieved by a stimulating purge; and Senator has recorded the case of an adult suffering from gastric catarrh, in whose breath and urine sulphuretted hydrogen had been detected, and who had more than one attack of collapse lasting for a few minutes and accompanied with pallor, giddiness, and small, quick pulse; he recovered after purgation (*Berlin. klin. Woch.*, 1868).

PHYSIOLOGICAL ACTION.—*External.*—Simply dusted on the sound skin, sulphur has no irritant effect, but applied with friction, and especially if in the form of ointment or lotion, it causes a moderate degree of irritation; much more if the surface be excoriated. The alkaline sulphides, such as those of potash and of lime, irritate severely if applied in strong and warm solution to a delicate skin. Sulphur and some of its compounds have the power of destroying the lower forms of vegetable and animal life; whence their practical value as “anti-zymotic and anti-parasitic” remedies. Binz attributes this power to the formation of *sulphurous acid* under the influence of exposure to the air, and to heat, and to contact with protoplasmic organisms (*e.g.*, the *oïdium Tuckeri* of the grape). The subject of disinfection is more fully considered under the heading of Sulphurous Acid.

PHYSIOLOGICAL ACTION.—*Internal.*—Given to animals, it produces at first some stimulant effect. Benk states that its after-effect is of a reverse character, and that this is accompanied by, and is probably due to, intestinal irritation. Hertwig found also that animals were readily brought under the influence of the drug with production of diarrhœa. After two 1 oz. doses of sulphur, a man had rigors, headache, temperature 104, pulse 120, fœtid breath, contracted pupils, and sweating, with tympanitic abdomen and much pain, vomiting and purging with blood—in brief, the symptoms of a strong irritant poison, but he gradually recovered (*B. M. J.*, ii., 1888).

Circulatory System.—Sulphur and the sulphides, in moderate doses, stimulate the circulation, especially in the arterioles of the skin and mucous membranes, and the venous circulation within the pelvis. Congestive headache, vertigo, and sometimes hæmorrhage have been traced to the use of the drug and of mineral waters containing it. If a solution of a sulphide be added to blood the oxyhæmoglobin is reduced and a compound called sulpho-hæmoglobin or sulpho-methæmoglobin is formed, which is something like methæmoglobin. This has a dark, reddish-brown colour when in bulk, and a greenish colour in thin layer; it has a characteristic spectrum.

Secretion and Excretion.—Buchheim and some modern writers express doubts as to whether sulphur really increases secretion from the bronchial mucous membrane and the skin; but

I have frequently seen an augmentation of these secretions under the use of this remedy. According to Boecker, the urinary water and solids are increased in amount under the action of sulphur; Presch observed that the excretion of urea was notably augmented; Umbach also found it increased after the administration of calcium sulphide.

Neuro-Muscular System.—The subcutaneous injection of a solution of sodium sulphide into a frog causes muscular weakness and a narcotic effect; this is much later followed by an increased reflex excitability and convulsions which persist for a long time. In mammals it causes convulsions, which have been supposed to be cerebral, because they do not affect the lower limbs when the spinal cord is divided, but this in itself is not sufficient evidence. It causes paralysis of the vaso-motor centre, and death by paralysing the respiratory centre.

Cutaneous System.—Some dark coloration and much irritation of the skin may occur from the internal use of sulphur. I have seen a red papular eruption from it, and also occasionally boils and carbuncles. The waters of Harrogate, Barèges, Aix-la-Chapelle, etc., have been known to produce such effects.

Digestive System.—The *sulphides*, in small doses, excite a sensation of warmth at the epigastrium; in excessive doses, they may cause gastro-enteritis, and even “insensibility and speedy death” (Ringer). Sulphur itself passes through the stomach unchanged, but in the duodenum a small portion is converted into alkaline sulphides, which act as irritants, and are the cause of the laxative action. Sulphurous waters in the quantity of several ounces often cause pain and oppression in delicate subjects. Doses of 20 to 40 gr. and upwards of sulphur in powder cause moderate stools, semi-solid in character, and passed with perceptibly increased peristaltic action; hence it has been presumed that the muscular coat is mainly acted upon. Sundelin maintained that sulphur had a “specific” action, on the mucous coat, but we cannot speak positively about this. The too prolonged use of sulphur as an aperient may induce intestinal catarrh.

Husemann holds the view that the unaltered and unabsorbed sulphur mechanically protects the intestinal mucous membrane like bismuth, and this would explain the fact that large doses relax without colic, whilst moderate doses relax equally but with

some colic, and small doses sometimes cause pain without the relaxation.

SYNERGISTS.—As a stimulant, sulphur is aided in effect by the volatile oils; as an alterative, it has analogies with arsenic, phosphorus, and possibly iodine (Gubler); as an aperient, magnesia and the acid tartrate of potash assist its action.

Antagonists.—Sedatives, refrigerants, astringents, and cold oppose the ordinary action of sulphur; quinine and bromides have a specially antagonistic effect.

THERAPEUTICAL ACTION.—*External.*—**Parasitic Skin-Diseases—Scabies.**—Sulphur is one of the substances fatal to acari, and it still remains one of the best, as it is the commonest remedy for scabies, though Dr. McCall Anderson and others have objected to it as too irritant.

It is nearly certain that sulphur, when used by itself or mixed with lard, has simply a mechanical effect on the epidermis, but when carbonate of potash is added to the ointment, *sulphurated potash* is formed, and this compound quickly destroys the acari. We know, from clinical observation, that these insects often live in the plain sulphur ointment for several days, without much apparent detriment, whilst, as Kuchenmeister says, “the acari, kept in a solution of sulphurated potash, die in a quarter of an hour.” When applied to the skin, therefore, sulphur probably acts only after combination with the secretions.

The strength and the frequency of the application should be varied according to the delicacy of the patient's skin and the amount of the eruption; the more active the preparation, and the more thorough its use, the quicker will be the cure. Thus, painting the body with a solution of chloride of sulphur in bisulphide of carbon (12 parts in 100) is said to cure in five minutes (Med. Times, i., 1856); whilst Bourguignon's or Vlemingx's formula with lime and sulphur is allowed half an hour. This is prepared by boiling 1 part of quicklime with 2 parts of sublimed sulphur in 20 parts of water, boil to 10 parts and filter; it is rubbed into the skin for half an hour, and one pint is sufficient for each time. The University College Hospital form is milder, with slaked lime and sulphur, of each 4 parts to distilled water 35; boil, evaporate to 20 and filter: this contains pentasulphide and oxysulphide of calcium, and will bear diluting with an equal quantity of warm

water. M. Hardy's method, with soft-soap frictions, warm bath, and anointing with 2 parts of sulphur to 8 of lard and 1 of potash carbonate, effects its purpose in four hours (Brit. and For. Rev., ii., 1852); but such results are liable to be accompanied with unnecessary irritation and pain to the patient. Dr. Tilbury Fox, having seen eczematous eruptions induced by too strong an ointment, advocated the use of a mild one (1 part in 16, *i.e.*, $\frac{1}{2}$ dr. to the ounce of lard) *to the wrists and between the fingers only*, in acute cases accompanied with general irritation (Lancet, ii., 1871); but, as a rule, the ointment of the selected strength should be applied to every part. A warm bath, lasting half an hour, and thorough cleansing with soap and friction, should precede the inunction; then, after drying, either the mild ointment of Fox, or the simple ointment of the Pharmacopœia (1 part in 10), or one of intermediate strength (1 part in 8, with $\frac{1}{2}$ a part of potassium carbonate and 2 p.c. carbolic acid) should be plentifully rubbed over the trunk and the limbs, especially the flexor side of the limbs and between the fingers and toes; and then socks, gloves, drawers, and jersey should be used to keep the ointment in contact with the skin (Liveing). After a night's application, a warm bath in the morning may be used to remove the odour of sulphur, but then a second or third inunction may be required; if the first can be left undisturbed for twenty-four hours, it will often suffice to cure. (The clothes worn must be disinfected.) In some cases a lotion of sulphuret of calcium (liquor calcis c. sulphure) acts better, because it is more thoroughly applied than an ointment; its use should also be preceded by a warm bath, and it need only be *gently* applied with a sponge or brush; if used with friction it may cause very severe irritation. Dr. Dolan speaks highly of this application (B. M. J., i., 1884).

A sulphur-bath is not so efficacious as these remedies, but is sometimes required, and may be made with $\frac{1}{2}$ lb. of sulphurated potash to 30 gallons of water—or with sulphur, hyposulphite of soda, and acid (*v.* Preparations). Wooden or porcelain vessels should be used for the baths, of which several will be required. Sulphur in vapour may also be employed (*ib.*). Friction with dry precipitated sulphur, the same being sprinkled on the bed-clothes, is said to be effective, in conjunction with ordinary warm baths (N. Y. Record, 1890).

Tinea Tonsurans.—Tinea Versicolor.—The parasites in these maladies are curable by sulphur applications (*v.* Sulphurous Acid), but a compound ointment containing ammoniated mercury acts better than simple sulphur ointment (Ung. hydrarg. ammon., with an equal part of Ung. sulphuris, is a good formula).

Sycosis Mentagra ("Barber's Itch").—In this disease, Hebra advises that the affected hairs should be pulled out, the chin well shaved every day, and a paste containing sulphur, glycerin, and alcohol, in equal parts, rubbed over the diseased skin every night and morning; by this means a cure is rapidly effected, but it is rather severe treatment. It is specially adapted for the parasitic form, but is useful also in the more common one, because sulphur lessens pus-formation.

Prurigo.—In chronic prurigo—especially when connected with phtheiriasis, but also in independent forms—an ointment containing sulphur with a preparation of tar is often of much service. Dr. McCall Anderson recommends 6 dr. of *pix liquida* in 4 oz. of ordinary sulphur ointment (*Lancet*, ii., 1869). Sulphur vapour baths are useful. In ordinary pruritus I have found a lotion of sulphurated potash very effective.

Eczema.—Psoriasis.—Seborrhœa.—When eczema occurs as a complication of scabies, Hebra joins with the sulphur an equal quantity of tar and half the quantity of chalk; and there are some stages of idiopathic eczema when sulphur acts as a useful stimulant, *viz.*, when the eruption is on the *decline*, but remains in obstinate chronic patches, especially about the legs. It acts best in lymphatic constitutions; but, as a rule, I prefer potash or tar applications to sulphur. I may say the same as to my own experience in chronic psoriasis, but compound sulphur ointments have been found useful in this malady, especially in the seborrhœic form and in seborrhœa generally. Dr. Wetzler states that ordinary psoriasis, when not much developed, can be cured by Aix-la-Chapelle waters alone, if prolonged baths can be borne. In very extensive and obstinate cases, however, he adds iodide of potassium to the water, and prescribes in addition sulphurous vapour baths, tar-frictions, etc., but the good results are probably chiefly due to the tar.

Acne.—In the *simple acne* of young people, occurring in the sebaceous glands about the face and shoulders, accompanied by comedones and without much general congestion, a fairly strong

preparation may be used, with potash, or a lotion containing 6 dr. of precipitated sulphur and 1 dr. of glycerin, with 6 oz. of rectified spirit (Anderson). When a moderate degree of irritation is present the proportions may be altered; thus, 1 dr. of sublimed sulphur may be rubbed up with a little alcohol, and then 2 dr. of the smoother variety may be added, with water to dilute sufficiently (Morris, *Lancet*, i., 1855); or a lotion that I commonly use with advantage is made with 2 to 4 dr. of precipitated sulphur, with the same quantity of spirit and glycerin, and generally some zinc oxide, in 6 oz. of rose water. Spirit of camphor or ether may be added to relieve itching or heat, and special indications for internal treatment must be considered. Sometimes *dusting* with the pure dry precipitated sulphur answers better than anything (Parsons, *B. M. J.*, i., 1879); it is also used in the form of soap. The local remedies should be lightly or firmly applied, according as they can be borne, left in contact all night, and washed off in the morning with mucilaginous decoctions or water.

For *acne rosacea*, one of the best applications is an ointment containing 2 dr. of the hypochlorite of sulphur in the ounce of rumex ointment (Wilson), or a lotion of $\frac{1}{2}$ oz. of sublimed sulphur in 4 oz. of elderflower water. The official ointment of *sulphur iodide*, which is still stronger, may be carefully used to chronic cases of any form of acne. A certain amount of temporary irritation must be expected from these remedies, and may require their occasional intermission, and the use of sedatives. The internal use of calcium sulphide should be conjoined with this treatment.

The old-fashioned "balsam of sulphur," made by boiling with oil, is also an effective remedy in many of the skin affections mentioned; it should be diluted with 4 to 8 of simple ointment, and the odour masked with lavender.

Rheumatism.—The friction of rheumatic limbs with sulphur is as ancient at least as Pliny (*lib. xxxv.*), and attention was directed to it again by Dr. Fuller, Dr. O'Connor, and others (*Med. Times*, i., 1858). They found it useful also in sciatica and lumbago, alternating with the frictions, close and constant covering with flannel. Rénard found it very serviceable in rheumatism affecting tendinous parts, in his own person, after an acute attack; it produced some degree of heat and increase of perspiration when it acted well. It should certainly be tried in all obstinate forms

of rheumatism, and especially that form which attacks the soles of the feet in those who are exposed to damp and cold.

It is in the different forms of chronic rheumatism and chronic skin-disease that baths of sulphurous waters are found most valuable.

THERAPEUTICAL ACTION.—*Internal.*—The therapeutical action of sulphur and the sulphides is somewhat similar, but the former is commonly used in small doses to produce an “alterative” and in large doses a laxative effect, and the latter to modify some acute conditions, especially when they are connected with suppuration in various stages.

Skin-Disease.—The *internal* use of sulphur for many skin-diseases rests on an old tradition, but is not much adopted in modern practice. I have tried it extensively, and although the alkaline sulphurous waters are useful sometimes, and in *acne pustulosa* and *rosacea* the calcium sulphide, in $\frac{1}{4}$ to $\frac{1}{2}$ gr. doses thrice daily, seems to help absorption of the tubercles and abate venous hyperæmia, yet, with these exceptions, I have not seen much advantage. Dr. Cane refers to sixteen cases of *acne* in which the last-named remedy was useful (*Lancet*, ii., 1878).

Scrofula.—**Swollen Lips, Glands, etc.**—Children are often disfigured by a chronic swelling of the upper lip and *alæ nasi*, which may be connected with a crack or fissure on the inner surface of the mucous membrane. Accompanying this condition, there often exists a tendency to dyspepsia, and indolent swelling of the mesenteric, cervical, or other glands.

Although we cannot wholly cure the constitutional tendency in such cases by sulphide of calcium, yet the general condition may be greatly improved by $\frac{1}{4}$ gr. doses given three times daily for a few weeks; in my experience the fissure has healed, the lip-swelling subsided, and the glands have grown less.

In cases where pus has formed, the effects of this remedy may be traced in the subsidence and disappearance of some of the swellings, whilst others progress quickly, maturate and discharge, and others that have been open and discharging unhealthily for some time take on healthy action and ultimately contract and heal. For permanent good results this treatment should be followed up by cod-liver oil and generous diet, and change to the seaside. As a rule frequent doses of the sulphide

are not desirable, as they are apt to derange the stomach and cause eructation of sulphuretted hydrogen.

Scrofulous Ophthalmia, etc.—In this affection I can recommend sulphide of calcium, especially when ulceration of the cornea is present; it also acts well in otorrhœa, and in almost all purulent discharges occurring in children, even if fœtid and obstinate in character.

Suppuration.—Calcium sulphide exerts a marked influence on the formation of pus. If given early it controls the inflammatory process, *e.g.*, in tonsillitis, either aborting it so that it does not go on to suppuration, or, if this takes place, controlling and limiting its extent, promoting a more healthy formation, a quicker evacuation, and a more rapid subsequent healing: this observation is much more generally accepted now than it was some years ago.

In the treatment of simple *abscess* I have frequently used it with much advantage; in tonsillar abscess (quinsy) it is particularly valuable, and in mammary abscess, if the time for belladonna or antimony is past, the sulphide is the best remedy.

In *bubo*, especially if indolent, and with scanty, unhealthy pus-formation, the sulphide will often determine a more healthy action; $\frac{1}{4}$ to $\frac{1}{2}$ gr. in pill every three or four hours is a suitable dose.

In ordinary *boils*, and in *carbuncles*, a compress moistened with sulphide of calcium lotion—(4 to 6 gr. to the pint of water)—should be applied. When eruptions of boils recur at intervals, I advise a course of the precipitated sulphur—5 to 10 gr. night and morning—for several weeks during the intervals, but at the time of actual maturation recommend the sulphide as acting more quickly: $\frac{1}{4}$ grain taken every two hours for six or seven doses often arrests the formation of a commencing boil. This is best given as a powder triturated with sugar of milk, and the powders must always be freshly made.

In *variola*, sulphide of calcium, I believe, often moderates excessive suppuration.

Syphilis.—In the later manifestations of this disorder, sulphurous waters have a good reputation, but in my opinion without sufficient reason. At Aix-la-Chapelle, for instance, the treatment is conducted mainly by mercurial inunction, and the sulphur waters used locally and internally can only be considered adjuvants to this more powerful remedy. I think they serve mainly to

cleanse and stimulate the skin, to regulate the action of the bowels and viscera, and to counteract any injurious effects that might arise from the mercury (*v.* Baths). I have seen advantage apparently follow from the use of sulphide of calcium in *syphilitic laryngitis*, when mercury had been previously taken to saturation.

Diphtheria.—The antitoxin treatment has largely superseded other forms of treatment for this malady, such as aconite, iron, iodine, bromine, etc., but at the time when pus is commencing to form, and the false membrane is becoming loosened from the mucous surface, the sulphide of calcium is useful, for it exerts the action already referred to, of assisting the healthy completion, and at the same time limiting the extent of the suppurative process. If commenced early in this stage in doses of $\frac{1}{10}$ to $\frac{1}{4}$ gr. every one or two hours it produces the best effects, but it is useful also even if begun after pus-formation is fully developed, and I believe it has some influence in lessening blood-poisoning. The value of steam-inhalation in helping on the natural changes of diphtheria and the formation of muco-pus and loosening of the membranes has been often proved, and is now well known. I find it still more efficacious if sulphide of calcium be added to the boiling water in the proportion of 4 gr. to the pint, so that a certain amount of sulphurous vapour is locally applied. The same solution is said to be very effective in spray frequently used to the throat—for children it may be diluted (*Pract.*, i., 1889).

The local insufflation of finely powdered sulphur was, until lately, much used for arresting the development of diphtheritic exudation (*Lancet*, 1894-95); but whether its good effect is only as a “scouring powder,” wearing off the membranes by friction, or as an anti-zymotic, in so far as it forms alkaline compounds and becomes dissolved in the secretions, is uncertain.

In **Laryngo-tracheal Diphtheria**, where we cannot always see the false membrane, I find the sulphide of calcium treatment indicated if wheezing, rattling sounds accompany the breathing, *i.e.*, when the membrane begins to be loosened, rather than in the first stage when the breath-sounds are of a dry and sawing character.

Chronic Sore Throat.—Dr. Guéneau de Mussy has specially pointed out the value of sulphur waters in glandular angina, which

under ordinary treatment is an obstinate malady. The waters of Eaux Bonnes are of remarkable efficacy in such cases; the sulphurous acid spray is also useful if not too irritating.

There is some evidence that a daily dose of sulphide prevents or limits the infective power of *influenza*, *i.e.*, that those who take the drug escape the malady (Green, B. M. J., i., 1895).

Asthma.—Chronic Bronchitis.—In cases with much cough and profuse secretion, sulphur will often relieve, lessening and modifying the expectoration: I have seen this in many instances. The old physicians described it as “*balsamum pectoris*,” and it still forms part of some quack “*nostrums*.” Dr. Graves records his experience in its favour. Binz suggests that sulphuretted hydrogen being excreted by the bronchial mucous membrane may partially anæsthetise the terminals of irritated bronchial nerves, and advocates for the continued use of small doses of sulphur in asthma are not wanting (Duclos, Bull. Thérap., 1861). I have seen cases marked by loud wheezing, profuse but difficult expectoration, troublesome palpitation, and nocturnal spasms of severe dyspnœa, improve quickly with 5 to 10 gr. of sulphur taken thrice daily. The compound lozenge is a good form. The sulphur springs of Weilbach are celebrated for relieving cases of chronic bronchitis, especially when complicated with hæmorrhoids.

Phthisis.—Sulphur was well known to the ancients as a remedy in consumption, and Galen ordered phthisical patients inhalations of the vapour from the crater of Etna. It is not much used internally in modern practice, but for chronic phthisis the springs of Weilbach have a favourable reputation.

Sutro reported cases improved under sulphur (Med. Times, i., 1862), and I have seen advantages from its use internally and by inhalation. Dr. Dewar relates instances where sulphurous acid and steam acted unexpectedly well on phthisical subjects exposed to them (Med. Times, i., 1867). A spray containing sulphurous acid facilitates expectoration, and also disinfects and lessens purulent secretion, and so far relieves certain symptoms, but has no specific power over the disease.

Chronic Rheumatism.—Sulphur frictions for rheumatism have been already mentioned, and the drug was formerly considered a good internal remedy for chronic muscular and articular pain, and no doubt it is often of value when given in doses of

from 5 to 20 gr. twice daily for some time—I think the smaller doses give the better results. Remedies calculated to produce diaphoresis, such as vapour baths, should be generally combined with its use. Guaiacum is also well conjoined with it. In acute articular rheumatism it has little or no power, but Sir A. Garrod has recently spoken well of it in chronic rheumatic arthritis (*Lancet*, i., 1889).

Mercurial Tremor.—Mercurialism.—In cases of palsy and tremor connected with the action of mercury, sulphur is useful (*Lettsom*) and deserves trial; it is said also to neutralise acute mercurialism accompanied with salivation, and may be given in 5 to 10 gr. doses at the same time as chlorate of potash. I have known it greatly relieve the colicky cramp and looseness of chronic mercurial poisoning; on the other hand, in patients who have taken mercury at some previous period, sulphur, like iodides and other powerful alteratives, has sometimes produced a fresh salivation.

Lead Colic.—Lead Palsy.—In these conditions sulphur has been found available, as it lessens reabsorption of the lead from the intestine, but iodide of potassium is now proved to be a better remedy. In an epidemic of lead-poisoning at Havre, M. Marguerette found sulphur give much relief; it required to be exhibited at first in very large doses (50 grammes the first day), these being afterwards gradually diminished as the symptoms improved (*Bull. Thérap.*, 1867).

Hepatic Disease.—Chronic enlargement of the liver, with obstruction to the portal circulation, accompanied as it usually is by hæmorrhoids, is often much benefited by a course of sulphur, or of calcium or potassium sulphide.

Constipation.—Hæmorrhoids.—The mild action of sulphur renders it a useful aperient for children and delicate persons, especially if there be congestion of the rectum or pelvic viscera. In cases of hæmorrhoids it is one of the best laxatives, and if not powerful enough may be combined with bitartrate of potash, or with confection of senna. In cases of fissure of the anus, active purgatives not being admissible, sulphur is useful; also as a remedy for constipation in cases of stricture or prolapse of the anus. In the treatment of piles, sulphur need not be given in quantity sufficient to produce a laxative effect, unless this is otherwise re-

quired, for it can relieve without any direct aperient action. The ordinary dose should be 5 or 10 gr. morning and night. Weak sulphur ointments locally applied favour the good result. The remedy may also be used in the form of vapour, and if the fumes from burning sulphur can, by means of apparatus, be applied directly, they often relieve congested, painful, and bleeding piles—this is a popular domestic “cure” in some parts of the country. Dr. Thorowgood attributes to sulphur a special value in torpor of the colon, which often causes or complicates dyspepsia; he recommends 10 to 20 gr. to be taken in the early morning with *nux vomica*; the lozenges of Holsverck contain the same ingredients (*Lancet*, i., 1869; *Times*, i., 1858); and Sir A. Garrod speaks highly of *trochiscus sulphuris*, which he considers to form a soluble sulphide in the duodenum rather than in the stomach (*Lancet*, i., 1889).

Diarrhœa.—Dysentery.—Cholera.—Dr. Blacklock, of the Madras army, and Dr. Graves quote an extensive experience in favour of the efficacy of sulphur in these maladies; the latter observer combines it with soda and spirit of lavender, and in severe cases with opium (*On Cholera*, 1865). Mr. Prosser also finds drachm doses given with mucilage to be “one of the best remedies in epidemic diarrhœa and cholera” (*Lancet*, ii., 1866). This is not a general experience, nor is it mine, although I have found sulphur in 2 and 3 gr. doses useful in the fœtid, watery diarrhœa of scrofulous children; also in some cases of chronic dysenteric diarrhœa with tenesmus.

Disorders of Generative Organs.—Sulphur has been useful in cases of sexual irritation arising from hæmorrhoidal congestion, and when the menses are delayed in weakly and phlegmatic persons, it has, when used as an habitual laxative, some influence in bringing on the flow. On the other hand, it has been recommended for relieving uterine congestion and the disturbances of the climacteric period.

Ascaris Vermicularis.—Precipitated sulphur is often a simple and efficient remedy for these parasites; 5 to 10 or 15 gr. should be given daily, morning and night, for some weeks.

PREPARATIONS AND DOSE.—*Precipitated sulphur* is more finely divided, and is thought to be more active, than the sublimed form;

the dose of either is, however, the same—5 to 10 gr. as a stimulant, 20 to 60 gr. as a laxative; it is well given in milk, honey, or treacle. From precipitated sulphur a *trochiscus sulphuris* is made containing 5 gr. with 1 gr. acid tartrate of potash. The other official preparations are made from sublimed sulphur, and are *unguentum sulphuris* (1 to 9 benzoated lard); *confectio sulphuris*: dose, 60 to 120 gr. as laxative, 5 to 20 gr. as alterative; *pulvis glycyrrhizæ compositus* (sulphur, liquorice, fennel, senna, and sugar): dose, 60 to 120 gr.; *calx sulphurata* (calcium sulphide): dose, $\frac{1}{4}$ to 1 gr. in pill; *sulphuris iodidum*—*unguentum sulphuris iodidi*: 1 in 25. *Potassa sulphurata* is not given internally, but may be used as a lotion, 1 dr. to $\frac{1}{2}$ pint of water; and as a bath, $\frac{1}{2}$ lb. to 30 gallons of water in a porcelain or wooden vessel. The “Sulph-aqua” packets from a company at St. Helen’s provide a good form of bath which does not discolour paint. A so-called hypochloride of sulphur is prepared by saturating thin layers with chlorine gas; it is a pale yellow powder containing sulphur and chloride.

The *balneum sulphuris compositum* (Startin) is—Precipitated sulphur 2 oz., hyposulphite of sodium 1 oz., dilute sulphuric acid $\frac{1}{2}$ oz., water 1 pint; to be added to 30 gallons of water. A sulphur vapour bath may be prepared by evaporating $\frac{1}{2}$ to 2 oz. of the solution of lime and sulphur by means of a spirit-lamp placed under a suitable arrangement of chairs and coverings; the face should be protected from the vapour. An apparatus for vaporising sulphur for inhalation is described by Adams (*Lancet*, ii., 1891); and the “sulphur candle” is a convenient form.

ADULTERATIONS.—The precipitated sulphur commonly sold, especially before the passing of the Adulteration Act, contained a large proportion of sulphate of lime; this was due to the employment of sulphuric acid instead of the hydrochloric acid ordered in the B. P., but a former L. P. contained a preparation made with sulphuric acid, and known as “milk of sulphur.” This name has now been transferred as a synonym to the modern “precipitated sulphur,” and druggists have been prosecuted for supplying the lime compound when asked for “milk of sulphur”; although convicted by some magistrates of offences against the Act, the convictions have mostly been quashed on appeal to a higher court, on the ground that “milk of sulphur” is known by trade custom to be a distinct thing from the pure precipitated form (*B. M. J.*, i., 1877; *Lancet*, i., 1876). An adulterated specimen is whiter, with only a slight yellowish tinge, and when pressed looks silky and glistening: under the microscope crystals may be seen in thin tables or elongated prisms, and on exposure to a red heat lime is left as a white ash (*Med. Times*, i., 1853). Washed Sicilian

sulphur is nearly always pure, but that prepared from pyrites *often contains arsenic*. Water, after agitation with sulphur lotum, should not redden blue litmus paper, showing that no free acid is present.

PHOSPHORUS, P = 31 (30·8).

This non-metallic element was obtained in the seventeenth century from the urinary phosphates by Brandt of Hamburg, and by Dr. Boyle in this country. London was, for some time, the principal place of its manufacture, so that it became known as "phosphorus anglicanus." It does not occur free in nature, but may be obtained from its compounds in two allotropic modifications, namely, as yellow and red phosphorus. It forms with oxygen two compounds, phosphorus trioxide (P_2O_3), and phosphorus pentoxide (P_2O_5). The latter combines with water in different proportions to form two distinct acids known as metaphosphoric (HPO_3) and orthophosphoric (H_3PO_4). A third acid, pyrophosphoric ($\text{H}_4\text{P}_2\text{O}_7$), is prepared from orthophosphoric acid by the action of heat. All these acids form salts, the ordinary phosphates being compounds of orthophosphoric acid.

Phosphorus occurs in the bodies of animals, especially in the bones and in nervous tissue; phosphates are also found in the blood and urine. It occurs in bone chiefly as calcium phosphate, which constituent is most abundant in the bones of young animals. Animals obtain the phosphates necessary for the formation of their tissues from plants, especially from their seeds. Plants again draw their supply from the soil, whilst soils derive their phosphates from manure, also from small quantities existing in the oldest granite rocks, by the disintegration of which the fertile soils have been produced.

Phosphorus oxide has been obtained as a white wax-like solid, which is slowly soluble in water, and the action of the drug has been attributed to this (Lancet, ii., 1890).

Phosphorus trioxide combines with water to form phosphorous acid (H_3PO_3), the salts being known as phosphites.

Hypophosphorous acid (H_3PO_2) combines with bases to form hypophosphites. The anhydride has not been isolated.

Three compounds of phosphorus and hydrogen are known, of

which the symbols are PH_3 , P_2H_4 , P_4H_2 . The first of these is a poisonous gas called phosphuretted hydrogen, which has the odour of putrid fish. None of them are of therapeutical interest.

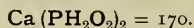
CHARACTERS.—The masses or pencils into which phosphorus is cast are colourless, white and translucent when fresh, but on exposure become coated with an opaque layer of crystals, which may be white, yellowish, or sometimes red from the formation of an allotropic variety of phosphorus. Phosphorus oxidises so easily that it needs to be kept under cold water, in which it is practically insoluble; in ether, turpentine, and oils, it is soluble to a great extent; in rectified spirit it is but slightly so (1 part in 320); 1 part dissolves in 200 of ether, 1 in 100 of most fixed oils, in 25 of chloroform, but in bisulphide of carbon it is wholly soluble. ("Fenian Fire" is the term given to a very inflammable solution in this liquid, containing 70 per cent. phosphorus.) Naunyn states that phosphorus is very slightly soluble in water at 96° to 104° F.; it is more soluble in organic fluids. The element is soft and flexible at ordinary temperatures, melts at 110° , and takes fire at a little over that point; it is luminous in the dark, and, when exposed to air, gives off white vapours of phosphorous acid, exhaling an odour *sui generis*, which has been compared to that of garlic.

On exposure to sunlight or to heat without access of oxygen, it is converted into red or "amorphous" phosphorus—a brittle powder which is not acted on by the air, and is insoluble; when volatilised, this reverts to the ordinary form. Amorphous phosphorus has been, by some observers, credited with physiological activity. Thus, Bednar used it for a long period in small doses, and observed symptoms of excitation, trembling and clonic convulsions; but as much as 1 oz. has been given to dogs without perceptible effect. Thompson, in twelve carefully observed cases, found its action *nil*, and plausibly attributes its supposed powers to a slight admixture of ordinary phosphorus (Pharm. Journ., 1875). I believe it to be practically inert.

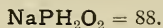
COMPOUNDS OF PHOSPHORUS.

Zinci Phosphidum—*Phosphide of Zinc*, PZn_2 (not official). A greyish friable substance, having a lustrous crystalline fracture, stable at ordinary temperatures, readily decomposed by weak acids, almost tasteless, but possessing active properties like those of phosphorus.

CALCII HYPOPHOSPHIS—*HYPOPHOSPHITE OF CALCIUM*.



CHARACTERS.—A white crystalline salt with a pearly lustre and a bitter nauseous taste. Soluble in six parts of cold water, insoluble in cold rectified spirit. Heated to redness, the crystals ignite, evolving spontaneously inflammable phosphuretted hydrogen. Its aqueous solution gives a white precipitate with oxalate of ammonium, and also with perchloride of mercury.

SODII HYPOPHOSPHIS—HYPOPHOSPHITE OF SODIUM.

CHARACTERS.—A white granular salt with a bitter nauseous taste, deliquescent, very soluble in water and in spirit. It ignites at a red heat, emitting spontaneously inflammable fumes of phosphuretted hydrogen. Its solution gives a white precipitate with nitrate of silver.

Besides the official hypophosphites, those of ammonium, potassium, iron and manganese are in use, and are sometimes given with quinine, strychnine and hypophosphorous acid (B. P. C.).

ABSORPTION AND ELIMINATION.—Phosphorus taken by the mouth, and especially when finely divided or dissolved, is absorbed into the blood under the influence of alkaline, albuminous, or oleaginous materials which it meets in the stomach and intestine: the amount and the rapidity of its absorption are proportionate to the amount of such materials, and especially of fats, which are its *best* solvents. It circulates in the blood as free phosphorus: when oxidised into hypophosphorous or phosphoric acid, it loses its characteristic toxic influence. A certain amount of phosphuretted hydrogen is probably formed in the bowel—but if so it is relatively unimportant.

Portions of unabsorbed phosphorus pass sometimes with the fæces, rendering them phosphorescent, and the urine has presented a similar appearance: the element has also been found in a free state in the liver, ten hours after death (Dybkowski)—it is eliminated by it, and by the other glandular organs, by the skin, and by the lungs. In one case of fatal poisoning, phosphorus paste seems to have been applied on the hands and face only (Lancet, i., 1890).

PHYSIOLOGICAL ACTION.—*External.*—When applied in the solid form phosphorus has been known to catch fire on the skin, and, indeed, has been used as a moxa; it is liable to cause sores and even gangrene, and the same results may follow its use in ointment. In certain experiments on *dogs*, however, when pieces of the element were placed in the cellular tissue they remained unaltered, and no inflammation was excited, yet the animals died after a few weeks from phosphorus poisoning; whilst, on the other hand, rabbits and some other animals treated in the same way did not show either local or general symptoms; also when a dog swallowed a stick of phosphorus, it was afterwards found in an abscess, without other symptoms of local irritation.

Hence it is clear that pure phosphorus does not necessarily act as a local irritant.

The fumes cause irritation, catarrh, and even inflammation of mucous membranes, especially those of the conjunctivæ and bronchi; they have also a special effect on the vitality of the *periosteum* and *bone*, permitting of necrosis of exposed parts such as the maxilla and decayed teeth. It is only when the phosphorus fumes *directly* reach the periosteum or some raw vascular surface having immediate connection with the nutrition of bone, and when their application is prolonged under particular circumstances of temperature, and probably of oxidation, that injurious effects are witnessed. The necrosis was formerly thought to be entirely due to the local action of the phosphorus fumes, when there were carious teeth in the jaw, but Stockman found staphylococci, streptococci, and tubercle bacilli in the pus from cases of cario-necrosis of the jaw in workers with phosphorus, and having noticed the frequent association of the disease in tuberculous subjects, believes that the condition is due to the action of the tubercle bacilli on the exposed bone, resistance of which had been lowered by the influence of phosphorus fumes. By taking precautions to maintain good hygienic conditions for rabbits who were exposed to the fumes of phosphorus after the bone of the jaw had been laid bare, he was able to protect them against cario-necrosis (B. M. J., i., 1899). The substitution of the amorphous for the yellow variety of phosphorus in match factories prevents the occurrence of such cases.

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—After taking, in ethereal solution, $\frac{1}{50}$ gr. each morning for ten days, and then $\frac{1}{100}$ gr. for nearly four weeks, I experienced increased thirst and dryness of mouth, with coated tongue, flatulent distension and eructations, and an uneasy feeling in the region of the gall-bladder, without nausea or vomiting; the motions were dark but healthy, the urine natural. There was slight headache and sense of fulness along the vertex and over the left temple, with some restlessness and sleeplessness. On discontinuing the medicine, these symptoms disappeared in about three days, and on resuming it at the end of a month I felt them return in about ten days' time. Other persons may take the quantity just mentioned without so much inconvenience, but larger doses

($\frac{1}{30}$ to $\frac{1}{15}$ gr. and upwards) are very liable to disorder the stomach, causing nausea and a sensation of warmth or irritation. The appetite may be at first increased, but in many patients dyspepsia quickly occurs, and nausea, flatulence, colic, or diarrhœa hinders the employment of at least the ordinary preparations of phosphorus. A silvery-white condition of the tongue may be caused, and the gums may become inflamed.

Zinc phosphide in any quantity above $\frac{1}{4}$ gr. readily induces vomiting. Professor Gubler, examining the effects of this phosphide upon artificial digestion, found that the phosphuretted hydrogen which was developed arrested the process, and he concluded that the same thing occurred with other preparations of phosphorus taken by the stomach; whilst Dr. G. A. Thompson attributes gastric irritation to the formation of hypophosphorous acid, and states that he has only seen these symptoms occur after the use of mixtures prepared with a *vegetable* oil.

Whatever the precise explanation may be, the limit of medicinal and the commencement of toxic doses is marked by more evident irritation of the digestive organs—the mouth becomes tender and sore, the nausea is accompanied with retching, vomiting and diarrhœa; tenderness and enlargement of the liver may be detected, and there is an icteric tint of the skin and conjunctivæ, with irritation of the same.

Genito-urinary System.—There is but little evidence of any stimulation to the generative functions or organs exerted by phosphorus given to healthy subjects, whatever may be its power in certain forms of disease. The stimulation that has been noted in some cases, both in men and animals, was not *special*, but merely a result of the *general* stimulus to the whole nervous system. Leroy, indeed, and some other French authors, have reported some temporary genital stimulation from large doses, and in a few cases of poisoning, irritation and excitement of the genitalia have been recorded, but they are to be explained as above. Thompson gave to two healthy adults 1 to $1\frac{1}{2}$ gr. of zinc phosphide daily for eight or nine days, and to another $\frac{1}{8}$ to $\frac{1}{6}$ gr. of free phosphorus until symptoms of incipient poisoning arose, but without any trace of aphrodisiac effect. Dr. Eames has reported similar negative results from observations with phosphorated oil, and Mr. Bradley's experience is to the same effect.

With special reference to this point, I have myself carefully experimented upon twenty healthy men. Ten of them took $\frac{1}{10}$ gr. daily for a fortnight; five took $\frac{1}{3}$ gr. each day for a similar period; and the other five took $\frac{1}{2}$ gr. every third day for five successive doses. Slight toxic symptoms occurred in some of the subjects, but, except possibly in one of the last set, no sign of increased sexual excitement was observed. I have, however, seen men from forty to sixty years of age, apparently in good health, but suffering from complete loss of generative power (in consequence either of previous sexual abuse, or of overtaxed brain and nervous system), in whom very small doses— $\frac{1}{200}$ gr. thrice daily—caused weak erections and involuntary emissions, but mental depression was developed to such an extent as to compel the suspension of the drug; this implies a state of irritation of the generative organs, but certainly not one of increased tone or strength.

With regard to its influence upon the *uterus*, we have evidence that long-suppressed menstruation may reappear under its continued use in small doses, but this may reasonably be supposed to be connected with improvement in the condition of the blood rather than with specific stimulation; in cases of poisoning, however, uterine hæmorrhage and abortion occur. It is said that if pregnant animals be poisoned with phosphorus there is fatty degeneration of the tissues of the foetus.

The urine under the influence of phosphorus becomes high-coloured; it may be phosphorescent, and have a smell of violets or sulphur, and urea is present in excess. The albumin which is often present in the urine in cases of poisoning with phosphorus is probably due to the fatty changes produced in the epithelial cells lining the tubules. Husemann reports the nitrogenous constituents increased in amount, and more recently in dogs poisoned by phosphorus Bauer found the excretion of urea 20 to 90 per cent. above normal (*Zeitsch. f. Biol.*, Bd. xiv., 1878); the phosphates are unaltered in quantity (Derlon). Leucin, tyrosin and sarcolactic acid have been found in cases of poisoning; lecithin is said to be diminished (Heffter, *Rev. des Sc.*, t. 37).

Osseous System.—Wegner has furnished definite proof that phosphorus stimulates the growth of bone, for after giving minute doses continuously to animals he found the epiphyseal cartilages ossified more quickly and more completely than usual, and the

cancellous and compact bone became more dense, even to the extent of obliterating the medullary canal (Virchow's Archiv, 1872; *cf.* p. 64). He also found that if lime salts were withheld from the food, the growth of bone continued, but it was soft in consistence. It should, however, be mentioned that Kissel could not find any effect of phosphorus on bone structure, though toxic effects were readily produced together with fibrosis (B. M. J., Ep., ii., 1896). Maas and Kassowitz, on the other hand, support Wegner's observations, and the effect on the jaw shows a special proclivity of phosphorus for bone (*v.* p. 48).

Nervous System.—The fact just recorded of phosphorus stimulating the growth of bone—a tissue of which it forms a component part—has led to the inference that it can stimulate the nutrition of nerve-tissue, of which also it forms a normal constituent; but the evidence on this subject is not very definite. Gubler describes the effect of $\frac{1}{30}$ to $\frac{1}{15}$ gr. to be a “general sense of stimulation more complete than that caused by coffee, more active than that produced by opium.” G. A. Thompson speaks of it as producing “exhilaration and increased capacity for exertion, both mental and physical, and an effect like that of alcohol without the subsequent depression.” He states also that if $\frac{1}{2}$ to 1 gr. be taken in the course of twenty-four hours the feelings described are more sustained, and transient giddiness or quasi-intoxication occurs. There seems to me some exaggeration in these accounts, but it is within my own experience that a general tonic effect may be obtained from these and smaller quantities of the drug. In cases where poisonous symptoms are developed, marked excitement, tremor, and spasmodic muscular twitching occur, and in severe cases cramp or partial paralysis, delirium, convulsion, collapse, or coma.

Circulatory System.—In accordance with the general excitation already described, the pulse and temperature are slightly raised about an hour after taking doses of $\frac{1}{30}$ gr.; and after such doses, given daily for some weeks, the circulation has been found more equable and more steady than before (Dr. Ford on fifteen patients, Amer. Jour. Insan., 1874). Large doses of phosphorus appear to directly weaken the heart—indeed rapid poisoning is said to cause death by this means; on the other hand, small and repeated doses cause weakness of the heart by producing fatty degeneration of its muscle. Thompson has noted dilatation of

the small vessels of the skin, and Pal has described a lowering of blood pressure due to the same cause—vascular dilatation. In toxic cases the pulse rises to 120 or more per minute, and the temperature to 102° to 103° F., though this condition is only temporary.

Sir W. R. Gowers has apparently proved that under the influence of small continued doses the proportion of red blood-corpuscles is increased (B. M. J., i., 1878), at least in lymphoma, and this interesting observation may throw light on the tonic power of the drug. On the other hand, toxic doses markedly diminish the number of red corpuscles as shown in fowls (Lancet, i., 1881). Hypophosphites in full doses dispose to hæmorrhage. The blood in several cases of poisoning has been found deficient in coagulability. This has been ascribed to an indirect effect through the liver and intestines leading to a reduction in the amount of fibrinogen (Corin and Ausiaux). According to von Jaksch it diminishes the alkalinity of the blood (Deut. med. Woch., Jan., 1893).

Toxic Action.—The poisonous symptoms produced are essentially of an irritant and destructive character, but vary in degree, and are often obscure and insidious—probably in proportion to the varying amount absorbed, or the chemical changes which the drug undergoes under different circumstances. Lecorché describes three forms of “acute phosphorismus”: 1, that produced by phosphorated hydrogen; 2, that by phosphoric acid; 3, a mixed form; but the clinical varieties described by Trousseau, or better by Dr. Guy, are of more practical importance—he names them as 1, the irritant; 2, the nervous; and 3, the hæmorrhagic form.

1. *The irritant form* is the most common: it is induced (on the Continent, not infrequently) by swallowing match heads, or a certain rat-poison paste, and is accompanied by pain, vomiting, and purging, sometimes with blood and phosphorescence. In the early stages there is pyrexia with nervous excitement, delirium and delusion sometimes erotic, though priapism is rare. Twitchings, cramps, and convulsions may occur, but later on follow prostration and collapse, loss of sensation, retention of urine, and partial paralysis, affecting mostly the extensor muscles.

2. *In the nervous form* these latter symptoms become much more marked, but there is little pyrexia; erythematous spots

occur in the skin, which is dry and yellow, and later becomes cold: dilatation of the pupil and strabismus are described, and the fatal termination comes on with somnolence and coma.

3. *The hæmorrhagic form* is less quickly fatal than the others. In it the ejecta are almost wholly sanguineous; bleeding occurs in and from the skin and mucous membranes, and many parts of the body. It is due partly to the altered state of the blood, and partly to general softening of the tissues, including fatty degeneration of vessels (Lebert). In women there is uterine hæmorrhage, miscarriage, or abortion—but these may be due to the irritant effects on the intestinal canal.

In all cases of phosphorus poisoning the liver becomes enlarged, and about the third or fourth day pain is felt over the hepatic region, followed shortly afterwards by jaundice, headache, and sleeplessness: the urine is found to contain bile, and generally albumin, leucin, tyrosin, and sarcolactic acid. The presence of bile is an argument that the jaundice depends not on suppression, but on occlusion of the biliary passages, which is probably catarrhal in character. In exceptional cases (in which, probably, only a small amount of the poison has been absorbed) there has been neither gastro-enteritis, nervous excitement, nor quick pulse, but the prominent symptoms have been jaundice and hepatic congestion. The time that elapses from the taking of the phosphorus to the appearance of symptoms varies from a few minutes to two days. Death, when it occurs, is usually from asthenia, but the course of the illness is not always steadily progressive; sometimes the severe symptoms subside for a few hours or days, and death takes place *suddenly* from failure of the cardiac muscle (Haber-shon, Med.-Chir. Trans., v. 50). A remarkable instance of subsidence of all irritant symptoms for four days when death occurred from hæmorrhage and collapse is recorded (Lancet, ii., 1891). A fatal dose may be stated as about 1 to 2 gr. for adults, but much less for children, in whom vomiting and convulsions are usually the prominent symptoms. Dr. Poore has recorded two instructive cases (Clinical Studies, 1897).

Tolerance.—The system may become habituated to the use of phosphorus to some extent, and a gradual increase of dose may be borne up to an amount which would not at first be tolerated. Any “cumulative action,” so called, may be explained by the

mechanical accumulation of the drug in the stomach and intestines.

Pathological Changes Induced by Phosphorus.—Ecchymoses and gangrenous spots have been found in the intestinal tract, together with swelling and softening of the mucous membrane and mesenteric glands; rarely perforation. The viscera are hyperæmic, and œdema and hæmorrhagic infiltration affect the skin, serous membranes, and other tissues, especially those of the mediastinum; hæmorrhage has also occurred between the spinal membranes, thus accounting for paralysis. According to the observations of Dr. Danillo, in cases of phosphorus poisoning, there are deposits of pigment of hæmatic origin in the central nervous system, while the cord shows evidence of either inflammatory irritation or diffused or central myelitis, according to the amount taken (*Gaz. méd. de Paris*, 1882). The blood itself is black and viscid, and in many cases, even during life, the corpuscles are destroyed and the hæmoglobin altered, so that it will not show the usual spectrum (*Lecorché, Voit*); in others, the corpuscles have been found normal after death, and the blood-pigment unchanged (*Lebert, Gubler*); but in all cases the blood and the solid organs contain an increased proportion of waste products, such as urea, creatin, sarcolactic acid, leucin, tyrosin, etc., and fatty degeneration affects every tissue. The muscles, including the cardiac muscle, are discoloured, soft, and fatty, the vascular walls are degenerated in a similar manner, the gastric glands and renal tubules are choked with fatty epithelium, and the liver especially is enlarged, yellow in colour, and its cells filled with fat globules, for, in protracted cases, degeneration of the cells occurs. That this is a true degeneration, and not simply deposit of fat, is corroborated by finding, in hardened sections of liver and kidney, that the structure is entirely obliterated by ether (*Lancet*, i., 1890). It is possibly as a consequence of this degeneration that the glycogenic function of the liver is abolished by phosphorus.

The condition described resembles closely that found in "acute yellow atrophy" of the liver, and the question of diagnosis has been raised in medico-legal cases (*Annales d'Hygiène*, 1869). An illustration of this is recorded by Surgeon-Major Martin, in a man admitted to Netley Hospital without any

history of poisoning, whose case was diagnosed as acute yellow atrophy—it was only after death that the real fact of phosphorus poisoning was disclosed by examination (B. M. J., i., 1878). An instructive case arising from the external application of phosphorus paste is recorded (Lancet, i., 1890). A frequent if not invariable result of chronic phosphorus poisoning is to establish a cirrhosis of the liver, kidney, and stomach. This cirrhosis is probably due to a direct effect on the fibrous tissue.

Fatty degeneration was found by Munk and Leyden in the tissues of frogs and rabbits within two or three days after giving phosphorus (Med. Times, ii., 1865), and since these researches its occurrence in phosphorus poisoning has been amply demonstrated, especially by German observers (Ziemssen's Cyclopædia). In Tamassia's experiments it was very rapidly produced. He injected 3, 4, 5, 6 gr. respectively into the rectum of four animals (dogs and rabbits); toxic symptoms occurred in about fifteen minutes, death in eight hours (the temperature falling 8° F.). In all four of the animals the kidneys, and in two of them the liver also, were in a state of fatty degeneration (Med. Record, Jan., 1878).

SYNERGISTS.—Arsenic is allied to phosphorus in its power of acting upon the blood (with advantage in small doses, in large doses with destructive effect), also in its action upon nutrition. Cantharides, oxygen, and stimulants have somewhat analogous stimulating powers.

Adjuvants are found in phosphoric acid, and in fatty and fleshy foods. Phosphoric acid has especially been shown to develop or augment the powers of phosphorus, probably from aiding in its solution and circulation (Personne). The brains of animals and the flesh of hogs are said to be rich in phosphorus, and *roast* food to retain more than *boiled*.

ANTAGONISTS.—**ANTIDOTES.**—Magnesium or calcium hydrates will neutralise the acid compounds of phosphorus, and charcoal will absorb phosphorous fumes. Bi-sulphide of carbon antagonises the excitant action of the drug, as also do sulphuretted hydrogen, anæsthetics generally, and cyanides (Gubler). Nitrate of silver was recommended as antidotal by Bellini (Med.-Chir. Rev., ii., 1875). Solution of potassic permanganate, $\frac{1}{3}$ per cent., also converts it into phosphoric acid (Pharm. Journ., 1892);

and a $\frac{1}{10}$ per cent. solution has been used by the stomach pump successfully (Lancet, i., 1892).

In an important experiment by Crocq, oxygen was used as an antidote, defibrinated blood charged with the gas being injected into the veins, with the effect of restoring to its normal condition the dark, pitch-like blood of poisoned animals (*ib.*).

But the two special antidotes are sulphate of copper and ozonised oil of turpentine. With any soluble salt of copper, phosphorus forms a black phosphide, which is not poisonous; and as copper sulphate is also a good emetic, it is specially available for cases when the poison has been taken by the stomach, and when the remedy can be given soon afterwards. Five grains should be given every two or three minutes until free vomiting is induced, and then either continued in small doses with opium, or turpentine substituted.

If oil of turpentine be brought into contact with phosphorus at a suitable temperature, a crystalline white solid is formed—terebinthino-phosphoric acid—which is not poisonous. To produce this result, the oil must come into *direct* contact with phosphorus in the stomach, and in the proportion of about 100 parts to each one of the latter. It should be given in 40 m. doses in mucilage every fifteen minutes for an hour. Eleven hours is the longest time that has elapsed before the administration of the remedy in successful cases. Moreover, it is not every kind that will act well; the pure rectified oil, and much of that imported as German and American, do not form the crystalline acid, and hence a difference in the results of some observers. It is the crude, acid, French oil, or that which has been ozonised by long exposure, which gives reliable results. It is said that milk lessens its good effect, and other fats and oils must be withheld, as they dissolve any phosphorus which may be in the alimentary canal and facilitate its absorption.

A case illustrating the value of both the antidotes recommended occurred in my practice some years ago. A young man (irresponsible) swallowed some pieces of solid phosphorus, and, whilst his friends were gone for assistance, gashed his throat and body with a razor. When I saw him, the most pressing need was to stay hæmorrhage, and while copper sulphate and turpentine were being procured, mustard and water was ad-

ministered. This and the copper produced free emesis, with rejection of a piece of phosphorus 2 in. long. I then gave turpentine in milk (also in water), and still encouraged vomiting, because from the small pieces left in the patient's bottle of phosphorus more was thought to have been taken. Eventually two other pieces, $1\frac{1}{2}$ in. and $\frac{1}{2}$ in. long, were rejected, after having been in the stomach at least three hours, and after several more doses of turpentine the patient made a good recovery.

A case is reported of a man who swallowed 120 match-heads, and then took turpentine to increase the effect: he did not vomit, but recovered (Med.-Chir. Rev., ii., 1869). The subject has been again investigated by Dr. Bush (Dorpat), who gave to various animals poisoned by phosphorus, emulsion of turpentine about an hour afterwards, and with good result (Lancet, ii., 1892).

THERAPEUTICAL ACTION.—*Internal.*—The value of phosphorus lies in its power of strengthening the nervous centres when their activity is impaired; also, since debility of the nervous system is associated with other than purely *nervous diseases*, a tonic of this kind has a wide field of usefulness, and is applicable, not only in nervous exhaustion and pain, but in many conditions of adynamia. Rabuteau, however, states an opposite view when he says: "I do not hesitate to assert that this poison has never cured anything up to the present time, and I would never prescribe it; it has always been useless" (Traité de Thérap.); Dr. T. Oliver also remarks that "clinical experience lends little weight to its recommendation for nervous affections," whilst Dujardin-Beaumetz, A. Thompson, and others have recorded wonderful results from it. The truth probably lies between the two extremes, and we must not forget that some failures may be accounted for by inactive preparations of a drug always difficult to dispense.

Neuralgia.—Eighty years ago, Von Lobel, a physician, related his cure by an ethereal solution of the drug from an inveterate cranial neuralgia, which was accompanied with debility and failure of mental and sensory power. He took $\frac{1}{4}$ gr. every two hours, and (with one relapse) was restored to health in a short time, and after only a few doses. This experience was corroborated to some extent, and the remedy came into great repute, but was soon found to be a dangerous one and difficult to manage,

and it gradually fell into disuse, no doubt owing to the largeness of the doses. Mr. M. Bradley published a case of neuralgia of the chest-walls, rapidly cured by "tincture of phosphorus," after failure of all recognised remedies, and later he recorded other successful results (B. M. J., ii., 1872). In the following year Dr. Slade King added testimony to its value in doses of $\frac{1}{30}$ to $\frac{1}{20}$ gr., and Dr. Ashburton Thompson recorded forty consecutive cases either cured or relieved (Pract., 1873); Mr. Sanger referred to an equal number, and Dr. Hammond praised it in America (Pract., i., 1877).

Dr. Radcliffe early employed it with good results, especially in "anginoid pain"—a *cardiac* neuralgia. It was found useful in cases connected with extreme general debility—whether from over-lactation, hæmorrhage, or simple asthenia—in cases due to pregnancy, to cold, and to local irritation, such as carious teeth, and even to rectal cancer (Thompson). Anstie's experience was not so favourable.

I have myself seen much benefit from it in many of the above cases, also in *uterine neuralgia* occurring in sensitive patients, and induced either by protracted lactation, sexual excess, or by mental or local causes. The severe pain is apt to come on just before or during the monthly period, and then $\frac{1}{100}$ to $\frac{1}{50}$ gr. should be given three or four times daily; during the interval the smaller dose should be given, and less frequently.

For upwards of twenty years I have been accustomed to use phosphorus in intercostal neuralgia, and can speak favourably of its power. I have notes of fifty-six cases wherein the pain quickly subsided under this treatment, and did not, so far as I know, subsequently return. In some instances phosphorus succeeded where arsenic had failed; the dose was $\frac{1}{100}$ to $\frac{1}{50}$ gr. three times daily. In herpes zoster also phosphorus has in some instances relieved the severe pain.

Twitching of the facial muscles, especially about the orbit, often occurs in cases of neuralgia, and I have known it improved by phosphorus.

With regard to the dose in neuralgia and nervous disorders generally, I may say that in my experience the comparatively large doses recommended by Thompson cannot be tolerated for any length of time by the system. They may seem at first to

stimulate, or rather overstimulate, the nerve-centres, but after a short time they depress in a disastrous manner; whilst the small doses of $\frac{1}{300}$ to $\frac{1}{50}$ gr., continued for a length of time, nourish and strengthen nervous tissue, without any evidence of undue excitement; a gradual alterative action is what is desired.

Nervous Exhaustion. — Neurasthenia. — Gubler found phosphide of zinc remove the sensation of fatigue after hard work, improve the appetite and digestion, and conduce to sleep. He gave a $\frac{1}{2}$ gr. dose with an ordinary digestive pill at dinner-time, but such a dose is too large, and is very liable to nauseate. When the nervous system is jaded and below par, so that slight impressions are too deeply felt, and the nerve-controlling power is impaired, phosphorus has been found to supply what is wanting for a time; also, it has been said to improve intellectual tone in those subjected to either monotonous brain-work, or to an unusual mental effort (Thompson). Travignot has reported good results from phosphorated oil in *diabetes*—without restriction in diet (Progrès Médical, 1884). In the convalescence from many acute diseases the hypophosphites are valuable, and the same may be said of conditions of general debility, whether arising from defective hygienic conditions, or from prolonged anxiety or over-strain.

In cases of **Chronic Exhaustion of Brain Power**, or of general nervous exhaustion consequent on chronic functional disease, small doses continued for some months are advisable, and have been plausibly held to supply to the nerve-tissue a vital element in which it is deficient, and to improve its nutrition, just as Wegner showed that the drug improved the nutrition of bone; and certainly its supply, in some form, to nerve-tissue is as necessary as that of iron to blood corpuscles.

Exhaustion of Fevers, etc.—The value of phosphorus in conditions of extreme exhaustion in advanced disease is one of the earliest recorded experiences of Kramar, Mentz, Leroy and others (1733-1798). They used it in the muttering delirium and incipient coma of typhus fever, the collapse of malignant “bilious fevers,” and the profound depression of extensive pneumonia. Bayle says: “In every disease where death is imminent from failure of vital force without much structural alteration, phosphorus is indicated. We see this in severe continuous fevers during their last stage, whether they be caused by some miasm,

typhoid fever, plague, etc., or by 'spontaneous alteration of the blood,' and in adynamic or putrid fevers (so called); in such cases phosphorus reanimates vitality, furnishes nature the means of effectually resisting the disease, and eliminating its material cause by natural excretory outlets. It is indicated, secondly, in all acute exanthemata when eruption has disappeared suddenly with aggravation of symptoms, measles, variola, erysipelas, low fever with exanthem"—and I can from my own experience corroborate this as to scarlet fever, etc. Bayle adds that it is useful in chronic gout and rheumatism (which are relieved through profuse excretion of sweat or urine), and in "all morbid conditions wherein it is proper to excite these secretions, and at the same time to stimulate vitality in a speedy and energetic manner" (*Bibliot. de Thérap.*, vol. ii.).

Phosphorus is recommended in intermittent fevers as often superior to arsenic, and as a good substitute for quinine (*Record.*, 1886).

Powers so extensive as these have not been accorded to phosphorus by more modern writers, but Mr. Clay has illustrated its value in the collapse of variola, and Dr. John Brunton in the adynamia of typhus and typhoid fevers; rapid improvement taking place under drachm doses of the following solution: Tinct. Phosph. Æth. (gr. $\frac{1}{3}$ ad 3 i) ʒ iii, Spt. Rectif. ʒss, Glycerini ad ʒ iss. About two grains were taken in the course of two days.

I have frequently prescribed phosphorus in the exhaustion of typhus and typhoid, and have sometimes seen remarkably good results from it; but, on the other hand, have been often disappointed, and cannot but consider it an uncertain remedy in such cases. I would place more dependence upon ammonia, camphor and other stimulants of that class, but if they failed, should have recourse to phosphorus.

Exhaustion of Generative System.—Impotence.—In such conditions phosphorus has long had a reputation, and was much valued by early authorities; but modern experience has shown its power to be more limited than was supposed. If the special exhaustion referred to be only part of a generally enfeebled state, it will doubtless improve as the general tone and vigour improve, but this system is not stimulated apart from the others; indeed, if it were so, this might be a serious drawback to the ordinary use

of the remedy. I may say, however, that in some of my own cases an irritable weakly condition of the sexual organs, traceable to previous early abuses or subsequent excesses, has been much benefited by continued doses of $\frac{1}{200}$ to $\frac{1}{100}$ gr. thrice daily.

Disorders of Menstruation.—Patients with scanty, watery, and irregular catamenia, sometimes suffer, about the time of the periods, from sick headache, and when this is the case a continued course of phosphorus increases the quantity and improves the quality and regularity of the menses, while the headaches frequently disappear. When the discharge is not only watery but too profuse in character, and somewhat delayed beyond the natural time, phosphorus is of considerable use, as it checks the overflow, relieves the backache, improves the mental depression, removes the nausea and vomiting so frequently attendant, and strengthens the general condition. It is also useful in profuse menstruation attended with excessive sexual excitement. The dose should rarely exceed $\frac{1}{100}$ gr. every two to four hours during the menstrual period, and morning and night during the interval. Bromide usually acts better.

Hysteria.—Nervous power is impaired in this affection, the emotions not being under normal control; more or less neuralgia is often concomitant, and altogether it is a condition in which we should expect phosphorus to be useful, and instances of its value are on record. The cases benefited by it have been acute or chronic, dependent on sudden shock, or gradually coming on with increasing weakness and despondency; in either form a period of debility is liable to be followed by convulsive attacks. I do not undervalue moral and hygienic treatment, but amongst medicines, phosphorus in doses of $\frac{1}{100}$ to $\frac{1}{20}$ gr. has proved efficient in my hands. When hysterical attacks are connected with delayed or suppressed menses, pain in the iliac and lumbar regions, neurotic vomiting, palpitation, and general excitement alternating with depression, I have found this remedy help to regulate the periods and cure the hysterical symptoms.

Epilepsy.—In true epilepsy it has, like most other nerve-tonics, been used and commended, but evidence of its really preventing the attacks is contradictory. Anstie observed it relieve the depression of epileptics and improve their temper and power of control (Med. Times, i., 1862). In the early period

of the disease I have known phosphorus prove beneficial. I remember, especially, the cases of two men, aged nineteen and twenty-three, whose attacks began soon after puberty, and who had taken large doses of potassium bromide without evident relief, and who became quite freed from their attacks during a course of phosphorus, and have continued so for years afterwards. The dose was only $\frac{1}{100}$ gr. three times daily, which was taken (irregularly) for twelve or fifteen months.

Melancholia.—Dementia.—Dr. S. W. Williams in this country, and Dr. Ford in America, have recorded a moderately favourable experience of phosphorus in these conditions (Journ. Ment. Sci., 1874, and Amer. Journ. Insan., 1874). Dr. Judson Andrews also has written in favour of *phosphoric acid* in different forms of insanity, but especially those tending to melancholia (*ib.*, 1869). I have notes of thirteen cases of recovery from this distressing affection in patients between the ages of thirty-two and forty-five years, most of whom showed well-marked symptoms, such as despondency and depression, suicidal impulse, fear of solitude, loss of sleep, etc.; they looked haggard, the face was flushed, and they complained of cold clammy skin, vertigo, and various disturbances of the digestive system. In addition to general treatment by exercise and different forms of bath and the occasional use of *nuxvomica* or aperients, I gave phosphorus, at first $\frac{1}{30}$ gr., afterwards $\frac{1}{100}$ gr., thrice daily, with the result that all recovered in the course of two to three months. My experience of fourteen other cases between the ages of thirty-five and fifty shows, however, that it is an uncertain remedy, and although quickly beneficial in some cases, in others it is disappointing.

Pneumonia.—Phosphorus is good in ordinary cases with difficult muco-sanguineous expectoration, very marked lowering of strength and evening exacerbations; also in later stages when either pyrexia has subsided and the patient is left very feeble, and does not progress towards convalescence, or again, when red hepatisation is complete, fever and prostration increase, and suppuration is imminent—although, when pus has actually formed, the drug is contra-indicated.

I have also had good results from phosphorus in *chronic pneumonia*; but when this occurs in tuberculous subjects with a tendency to hæmorrhage, the drug should be avoided. In acute

or chronic cases, complicated with *bronchitis*, phosphorus is less appropriate than some other remedies, such as ammonia.

Hypophosphites have been recommended in the treatment of pneumonia, but there is no evidence to show that they shorten the progress of the disease, or hasten the crisis of the acute lobar form.

Tubercular Meningitis.—A number of cases have been recorded in which recovery took place under the free administration of phosphorus (Greenway, B. M. J., i., 1884; Green, Pract., ii., 1884). Betz used it locally, rubbing into the scalp a weak solution in oil (Med. Times, 1885). It has been suggested that it acts by causing fatty degeneration and consequent disappearance of effused lymph.

Phthisis.—The action of phosphorus in this affection can only be considered palliative, but it moderates some troublesome symptoms. I have used it in various doses in upwards of 800 cases, of which I have a record, and am satisfied that it does not cure advanced tuberculosis, although it appears in many cases to arrest its progress, at least for a time, also to improve the condition of the throat and voice, and to relieve the dry harassing cough, the pain after food, and even the colliquative diarrhoea and night-sweats. It has also removed pleuritic stitches, and seemed to strengthen the general condition; on the other hand, its use is not free from danger, and requires caution, since it may induce obstinate hæmoptysis. These remarks apply also to the hypophosphites, as to the value of which much difference of opinion exists. Some authorities regard them almost as a specific, whilst others maintain that they are simply tonics and have no power of arresting the disease. The question has never been worked out from the point of view of modern bacteriology. The probability is that they improve digestion and the resistive power of the tissues, and render them a less suitable nidus for growth of the bacillus.

Chronic Diarrhoea in children, with frequent watery evacuations, abdominal pains, depression and emaciation, or the colliquative form, occurring, *e.g.*, in phthisical adults, has often in my hands yielded to phosphorus. Sometimes it is well to give a few small doses of Fowler's solution of arsenic with it.

Cutaneous Diseases.—The value of phosphorus in these maladies was mentioned by Cazenave, and in 1850 Burgess

recommended it in psoriasis and in lupus. It has been strongly recommended in lupus erythematosus by Dr. Bulkley. Sir W. Broadbent, inquiring how far the chemical analogies of drugs would act as a guide to their therapeutical effect, was led to use phosphorus in the same class of cases as arsenic, and he recorded six cases of eczema and six of psoriasis treated by the former drug; the majority of these were relieved or cured (Clin. Soc. Trans., vol. iv.). Dr. Eames has also reported successful cases under the same treatment (Dub. Journ., Jan., 1872).

In a case of Dr. Whipham's, whatever good was obtained in the first month of treatment was lost in the second, and in several cases within my knowledge—severe and chronic cases, it is true—phosphorus was given without benefit. It would seem, then, that it is uncertain as a remedy, and without denying its occasional power of relieving, I think, with the late Sir Erasmus Wilson, that it is indicated rather for the impaired nerve-condition accompanying many skin-disorders than for any direct influence upon the nutrition of the skin.

Bone-Disease.—Rachitis.—Fracture.—In cases of fracture, resection, and transplanting of periosteum, Wegner found that small continued doses of phosphorus stimulated the growth of new bone, especially in young animals; also that ossification in the foetus was promoted by giving phosphorus to the mother. It is noteworthy that he obtained similar results, though less in degree, from phosphoric acid and oxy-compounds of phosphorus, but not from the amorphous element, nor from lime phosphate.

I have myself seen good results from phosphorus in *caries* of bone, and in cases of *abscess* connected with necrosed bone it lessens suppuration and hastens the separation of the sequestrum; given during pregnancy it relieves the dental caries and neuralgia often incidental to that state, and I have given the hypophosphites successfully in such cases. It may be presumed that phosphorus, and such preparations of it, would also improve the nutrition of the foetus in weakly subjects, and I think they might often be used with advantage in chronic rachitis.

Kassowitz has reported an exceptionally favourable experience in rickets, founded on the treatment of 500 cases. Cranio-tabes disappeared, and good effects were produced on thoracic and spinal deformities and other symptoms after a few weeks' treat-

ment by small doses of free phosphorus, generally given as phosphorated oil. Experimenting on animals he found such doses increased the growth of *compact* bone, but larger quantities increased rather the *cancellous* tissue (Berl. klin. Woch., 1884).

These observations attracted much attention, and whilst they were supported by Genser, Boas, and others, the experience of Hensch, and, I think, of a majority of German as well as of English physicians, was not confirmatory (Revue Générale, 1885). More recently, observations on hens and rabbits taking phosphorus, have shown normal spongy bone replaced by hard tissue, and so it may be a proved remedy for osteoporosis, but as the lesions in rachitis are different it cannot be considered equally a direct or specific adjuvant for that disorder (Amer. Journ., i., 1899, from Jahrb. f. Kinderheilk. ; v. p. 50).

In **Osteomalacia** phosphorus has seemed of service. It is usually given with cod-liver oil and the good effect both in this disease and in rickets has been attributed to the oil. A case, however, has been recorded in which a relapse occurred when the oil was given without the phosphorus. Steinberg advises that its administration should be begun early and be continued for months (Zeit. f. klin. Med., xxi., No. 3, 1893).

Leucocythæmia. — Pernicious Anæmia. — Lymphadenoma.—For these blood—and gland—disorders, which are essentially of serious, if not fatal, import, phosphorus was advised some years ago, and Sir W. Broadbent offered evidence apparently in its favour. A boy with “essential anæmia,” prostration, diarrhœa, yellow waxy face, etc., recovered very quickly under phosphorus, and remained well for some time. In another case of “leucocythæmia,” treated in the same manner, inflammation of the spleen was said to be produced (Pract., i., 1875). In a woman with lymphadenoma, having symmetrical enlargement of cervical glands, anæmia, dyspnœa, etc., and who had been steadily getting worse for some time, “complete recovery took place” after taking phosphorus (B. M. J., ii., 1876). In two other cases—one very far advanced, the other chronic—the same remedy was successful. Some support was given to these observations by a case, under Dr. Wilson Fox, of “leukæmia splenica” occurring in a man, aged thirty-seven, in University College Hospital, for when extremely

enfeebled he began to take $\frac{1}{50}$ to $\frac{1}{30}$ gr. doses, and after three months' treatment had greatly improved; he died, however, in the following year (Lancet, ii., 1875). Mr. T. J. Verrall reported a marked case of subsidence of splenic enlargement and improvement in the blood-condition of an infant, after the addition of one minim of phosphorated oil to other remedies which had previously been taken without good effect (B. M. J., i., 1885).

If we add to these cases one of leukæmia (Sir W. Gowers), in which the use of phosphorus was followed by diminution in the size of the glands, and lessened anæmia (though albuminuria and death afterwards occurred), it will be seen that the evidence in favour of phosphorus is not strong, whilst in many cases it has plainly failed. Dr. Moxon objects even to receive Dr. Fox's successful case as one of leukæmia, because the white corpuscles in the field were "only twenty to thirty," and refers to about thirty cases of his own ("pernicious anæmia," apparently), all unsuccessfully treated by phosphorus (B. M. J., ii., 1876).

At the meetings of the Clinical Society at which this subject was discussed (November, 1876), Dr. Greenfield and Dr. Goodhart related unsuccessful cases, and Sir William Jenner referred to three of "splenic leucocythæmia," in which the remedy seems to have had a fair trial without good result. The question was even raised, whether it might not be responsible for some fatty degeneration found *post mortem*; but without laying stress upon that point the general conclusion of competent authorities, both at that time and since, has been adverse to the value of phosphorus in such cases.

It would seem, perhaps, to offer a better prospect in cases of *lymphadenoma* than of *leukæmia*, and especially in early cases, and more evidence must be collected before we can rightly estimate the true power of the drug. I have already referred to the increase of red blood-corpuscles, reported by Sir W. Gowers, under the use of phosphorus; this was in a case of "lymphoma," and the increase in one month was from 52 to 66 per cent., and in another month to 74 per cent.; $\frac{1}{30}$ gr. was taken three times and then six times daily—no other drug was given, nor were the circumstances of the patient altered; but we may say this, that much more benefit has been already recorded from *arsenic*, both in pernicious anæmia and in lymphadenoma, than from phosphorus.

The two remedies are, doubtless, allied, but the former is more trustworthy.

PREPARATIONS AND DOSE.—*Phosphorus*: dose, $\frac{1}{100}$ to $\frac{1}{20}$ gr., or less ($\frac{1}{300}$), *Oleum phosphoratum* (made with oil of almonds) contains 1 per cent. by weight of phosphorus: dose, 1 to 5 min. *Pilula phosphori* (1 in 90): dose, 1 to 2 gr. in pill. *Zinci phosphidum*: dose, $\frac{1}{20}$ to $\frac{1}{3}$ gr. in pill, with sugar of milk, and glyc. trag. (not off.); *calcii hypophosphis*: dose, 3 to 10 gr.; *calcii phosphas*: dose, 5 to 15 gr.; *sodii hypophosphis*: dose, 3 to 10 gr. (v. Calcium and Sodium). These may be given in solution in syrup, in cod-liver oil, or in mixtures.

Exception has been taken to the *oil* as disagreeing with the stomach,¹ to the *pill* as being too concentrated, or not soluble enough: and many other formulæ for the medicine have been published (B. M. J., i., 1879; v. Martindale's article on pills, B. M. J., i., 1902). It is commonly agreed that the free unoxidised element will produce effects which none of its chemical compounds can do, and it is desirable, therefore, to give it in its pure unaltered state.

An *alcoholic tincture* may be prepared by adding phosphorus in excess to boiling alcohol quite free from water; this will take up 1 gr. in 6 dr. 20 min. (Thompson), and, if carefully kept from light and air, will remain unchanged for some weeks: 3 dr. 10 min. of this tincture ($= \frac{1}{2}$ gr. phosphorus) added to 1 oz. 40 min. of anhydrous glycerin, with 5 min. of spirit of peppermint, is a stable and not disagreeable form.

I myself prefer an *ethereal tincture*, in which 1 gr. phosphorus is first dissolved in 1 dr. of pure ether; and this solution, after standing some days, is mixed with pure alcohol, so that a proportion of 1 gr. in 500 min. is preserved. From $2\frac{1}{2}$ to 5 or 10 min. of this ($\frac{1}{250}$ to $\frac{1}{100}$ or $\frac{1}{50}$ gr.) are readily taken, mixed with water, and the preparation is stable enough for all practical purposes, though it should not be kept long.

There is a compound tincture of alcohol and chloroform containing 1 gr. in 600 (dose 3 to 12 min.) and an elixir of the same with glycerin containing $\frac{1}{50}$ gr. in 1 dr. (B. P. C.): (dose 15 to 60 min.). There is also a good French syrup (Fauconnet).

¹ A medical man in France recently was fined for the death of a boy to whom he had given this oil with cod-liver oil: vomiting occurred after six doses, then jaundice, pain, delirium and death: the liver was fatty and phosphorus poisoning was presumed (Hale White).

Glycerophosphates.—These salts (not official) are now extensively employed as therapeutic agents, and appear to have a distinct sphere of usefulness; glycerophosphoric acid, itself a constituent of lecithin,¹ is a colourless, odourless fluid, having an acid taste and a specific gravity of 1.3.

It is bi-basic and forms salts, of which the glycerophosphate of lime is probably the most useful and the most frequently prescribed. It is a white crystalline powder, soluble in cold water and with difficulty in hot water. The ordinary dose for administration by the mouth is from 3 to 10 gr.; hypodermically from 2 to 4 gr.; there is also a neutral and an acid form.

Amongst other salts may be mentioned the glycerophosphate of iron, which is met with either as a whitish powder, or in scales; the glycerophosphate of sodium, which is a translucent straw-coloured pasty mass freely soluble and said to contain 18 p.c. of phosphorus; and the glycerophosphates of potassium, lithium, magnesium, manganese and quinine. A useful elixir of the glycerophosphates is made by dissolving two parts each of glycerophosphates of sodium and lime and one part of glycerophosphate of iron in 250 parts of aromatic syrup. The dose is from 2 to 4 dr.

Discovered in the yolk of egg in 1846, glycerophosphates were but little known before 1893, when Dr. A. Robin drew attention to the large amount of partly oxidised phosphorus in the form of glycerophosphoric acid eliminated in the urine of some neurasthenic patients: having obtained and administered compounds of this acid, he concluded that they increased the general metabolism of both organic and inorganic matter, principally the latter—as shown by augmented excretion of urea, chlorides and sulphates—though not of uric acid or of phosphates; at the same time they “favoured the current of assimilation of the albuminoid matters, and moderated denutrition of the nervous system and aided its reconstitution by remaining in the system” (*Acad. de Méd.*, Avril, 1894).

He indicated a wide range for their curative power, *e.g.*, in chronic gout, diabetes, phthisis, Bright’s disease and even Addison’s disease with “nutritive decay,” meaning rather the improvement

¹ Lecithin is an important constituent of nerve tissue, and is found also in the semen, the blood and the principal organs. Injected in the crystalline form, it has been proved to stimulate all vital processes (*Serona*, 1897).

of vital power than direct antagonism of such maladies ; similarly in any breakdown of the nervous system, as in the aged or after acute illness or lowering treatment ; in chlorosis and rachitis ; in chronic dyspepsia, especially with lessened acidity (after appropriate treatment) ; in neuralgia, ataxy, sciatica, spermatorrhœa and neurasthenia generally when marked by depression, headache and impaired power for mental and muscular work ; whilst he notes that insomnia, palpitation and phenomena of excitement may be aggravated (this is not my experience), and that the medication is not suitable in conditions of azoturia, or when "organic oxidations are above the normal," or in mental disease or general paralysis. His best results seem to have been from hypodermic injections (*Lectures, Bullet. de Thérap., Mai, 1895, etc.*). He speaks also of improvement in cases of muscular atrophy of various causation and Dr. Plicque of benefit in diphtheritic paralyses (*Thérap. Gazette, Dec., 1898*). Dr. T. Harris, using the sodium salt (15 to 40 min. doses of a 50 per cent. solution), reported some good results in cases of nervous exhaustion from overwork and in a few—not the majority—of neurasthenics, nor in true hysteria (*Manchester Therap. Soc., B. M. J., ii., 1899*). Dr. Wild reports a similar experience and found it good after influenza, Dr. Dreschfeld in some functional diseases (*Med. Annual, 1901*). Dr. Bordet found the acid glycerophosphates superior to the neutral in stimulating the organism and aiding digestion and liver action ; large doses acted as purgatives like soda phosphate (*Comptes. rend. Acad. des Sci., Avril, 1900*).

IODUM—IODINE, I = 127 (125·90).

Iodine occurs as the iodide of magnesium, sodium, and other alkalies, in sea-water, and in many mineral waters, such as those of Kreuznach, Woodhall, and Cauterets ; also in sponges and sea-weeds, in water-cress, beans, potatoes, etc. Molluscs, and the liver of the cod and other fish, contain iodine, and in the human organism minute quantities are commonly found, notably in the thyroid gland. It was discovered in 1811 by Courtois.

CHARACTERS AND TESTS.—Iodine forms heavy, bluish-black, glistening scales, which stain the skin yellow or brown, and have a

peculiar irritating odour. It is volatile, rising in violet-purple vapour at 400° . The sp. gr. of this vapour is 8.7 compared with air, that of the crystals 4.9 compared with water. It is soluble in alcohol, ether, and chloroform, and in water containing salt or potassium iodide, but very slightly soluble in pure water (1 part in 7,000). The best test for free iodine is starch solution, which forms with it a dark-blue iodide of starch. In testing for an alkaline iodide, nitric acid or solution of chlorine must be added before the starch, which should be cold, as the blue colour is lost on heating. The addition of caustic alkali also decolorises the solution, iodide and iodate of the alkali being formed— $6\text{I} + 6\text{KHO} = 5\text{KI} + \text{KIO}_3 + 3\text{H}_2\text{O}$. Iodine is closely related, chemically, to bromine and chlorine; it has a stronger affinity for oxygen than these, but, for all elements except oxygen, a weaker affinity.

COMPOUNDS OF IODINE.

POTASSII IODIDUM—POTASSIUM IODIDE

($\text{KI} = 166$).

CHARACTERS AND TESTS.—It occurs in white crystals, usually cubical and opaque, but sometimes octahedral and transparent. When pure, these are odourless, but they commonly have a slight smell of free iodine, and if this be present they are tinged more or less yellow: the taste is saline and disagreeable. They are very soluble in water and in six parts of rectified spirit. Nitrate of silver precipitates a pale-yellow iodide of silver, insoluble in ammonia. If the solution be first acidified with nitric acid, no precipitate should occur; if it does occur, chlorides are present. The most important adulteration—not, however, a very frequent one—is the iodate of potash, and this is detected by its insolubility in rectified spirit, and also by the blue colour developed on adding prepared starch and a little tartaric or other acid.

SODII IODIDUM—SODIUM IODIDE

($\text{NaI} = 150$).

CHARACTERS AND TESTS.—A dry, white, crystalline, deliquescent powder, having a saline bitter taste, readily soluble in water and spirit: gives the chemical reactions for iodine and sodium.

Ammonii iodidum—ammonium iodide (not official) is prepared in a similar way. It is a crystalline body, and being less stable than the preceding salts is usually stained yellow from free iodine. *Strontium iodide* has been much commended by Laborde and others. Iodides of mercury, sulphur, etc., are considered elsewhere.

The combination with hydrogen, *hydriodic acid*, HI , contains over 99 per cent. of the element and is said to be more active as an antiseptic and alterative in smaller dose than the alkaline compounds and without causing irritation. It is a heavy, colourless gas, very soluble in water and readily decomposed by air and oxidising agents, but may be fixed in the form of a

syrupy solution containing 1 per cent., U. S. P., or 1·28 per cent. (Gardner). *Hydriodic ether* may be obtained as a colourless liquid by distilling alcohol, iodine and phosphorus. The compounds of iodic acid—*iodates*—have been recommended (Lancet, i., 1882), though they have been considered likely to cause toxic symptoms when present in iodides (*v. p.* 77). The *calcium iodate*, $\text{Ca}(\text{IO}_3)_2$, precipitates on decomposing iodide solution with “bleaching powder,” and is a greyish-white powder, soluble 1 part in 380 water, with special antiseptic non-irritant properties (W. Mackie, Lancet, ii., 1900); *silver iodate* has astringent, and *lithium iodate* antilithic characters. The *Liquor calcis iodinatæ* of Dr. Woods contains 16 gr. iodine in the ounce and yields iodide and iodate on heating.

Iodolbacid is an albumin compound in the form of a yellowish powder containing 10 per cent. of iodine (Lancet, ii., 1900), and *Iodipin* is also an organic compound, with sesame oil (B. M. J., ii., 1899, i., 1902, Ep.), the advantage of both being that iodine is liberated so gradually in the stomach or bowel that less irritation and less iodism are produced.

Vin Nourry is a Malaga wine containing iodine, 5 centigrammes in 3ss, with double the quantity of tannin, in which form it is easily assimilated, as it is also in *Amylum iodatum*—iodised starch—prepared by triturating 1 part of the moistened element with 20 of powdered starch and drying.

ABSORPTION AND ELIMINATION.—Iodine may be absorbed to some extent by the unbroken skin, if the local inflammation excited be not too severe; a dilute solution is therefore better absorbed than a strong irritant tincture. If a limb be painted with tincture of iodine, and covered with oiled silk, drops of colourless liquid may be found upon it after a few hours; this liquid contains the drug altered in some way by the perspiration, and a similar alteration possibly occurs before its absorption. The drug may—under certain conditions—be absorbed by the skin in a bath containing iodine and potassium iodide, and from serous and mucous membranes (*v. p.* 164). Potassium iodide and other alkaline iodides are not absorbed as such, even when applied to the skin continuously in lotion or ointment, but after being decomposed by the acids of the perspiration, or of lard, etc., they evolve free iodine, which may be absorbed, as proved by its appearance in the urine (Rabuteau). Ammonium iodide is the alkaline salt most readily decomposed. Vasogen and some other vehicles increase absorption. Observations recorded in the *Bullet. Gén. Thérap.*, 1897, indicate that iodine paint is absorbed, but irregularly: iodoform and ethyl iodide quite constantly. Bachrach applied compresses of $2\frac{1}{2}$ per cent. potassium iodate solution to the limbs, and in healthy subjects found

iodine in the urine after fifteen minutes--in fever patients only after an hour or more (Cbl. f. med. Wiss., ii., 1879). By *mucous* surfaces these compounds are easily absorbed; thus, when a suppository containing 20 gr. of potassium iodide was placed in the vagina, 18 gr. were absorbed in twelve hours; glycerin diminished the rate of absorption, whilst a little free iodine increased it (B. M. J., i., 1878). *Serous* membranes absorb iodides still more rapidly.

Taken into the stomach in small or moderate doses, iodine coagulates and combines with albuminous material, and is probably taken up in part as an albuminate, though a larger proportion combines with the soda of the stomach contents, and becomes iodide of sodium before being absorbed. Rabuteau thinks this combination with sodium occurs, to some extent, in the blood. Alkaline iodides are either absorbed unchanged, or as iodide of sodium. Metallic iodides, such as those of iron, lead, or mercury, are decomposed in the alimentary canal, forming iodide of sodium, which appears in the urine, whilst the metal passes by the bowel or is deposited in the tissues. Absorption of iodides seems to be markedly promoted by ozonic ether, by ammonia, and some other stimulants.

Elimination.—Both iodine and the alkaline iodides are readily and rapidly eliminated by the different secretions, and may be detected in the saliva, the buccal and bronchial mucus, the tears, the milk, the perspiration, the urine, the serum of joints, etc. R. W. Taylor has reported evidence of elimination of iodine by the skin in the case of a man with pityriasis, who took large doses of the potassium salt whilst wearing a starched shirt; he had profuse perspirations, and a dark coloration, due to the formation of iodide of starch, appeared on his back. In another case of a man taking 10 gr. doses for syphilis, not only the linen but the hair became coloured brown (B. M. J., ii., 1891).

It would seem that almost all the iodine taken is excreted in the urine, for Scharlau recovered from that excretion 345 centigrammes out of 350, and according to Melsens very little can be traced in the fæces, the iodine that is excreted into the intestine being absorbed again by the lining membrane before it reaches the rectum. Rabuteau found a small quantity in the fæces, so long as it was present in the secretions; if diarrhœa occurred

the quantity was notably increased. Ehlers concluded that doses above 20 gr. are not completely absorbed; of that quantity he found 75 per cent. eliminated (*Annales Derm. et Syph.*, 1890).

The *rapidity* of elimination varies with the quantity taken, a large dose giving evidence of its passage very quickly. Ranke found traces in the urine three and a half minutes after administration, and even sooner in the saliva. Nothnagel also found it early—in ten minutes in the latter secretion. Dr. Richardson found it in the urine within one minute of injecting tincture of iodine into an enlarged bursa, and three minutes after breathing iodide of ethyl, iodine could be detected in the urine. It is an important practical point that the elimination of this drug is completed sooner than that of many others. Dr. Balfour noted that even if large doses of potassium iodide had been taken for many weeks, their elimination was complete within three or four days after ceasing to take them (*Edin. Med. Journ.*, 1868). Rabuteau, after 15 gr., found traces in the urine for three days; after 150 gr. for ten days; not afterwards. The greater part was eliminated during the first day, little passed on the second, and scarcely a trace on the third; in the dog, elimination was somewhat slower. Speck has stated that in Bright's disease the kidneys do not eliminate iodine.¹ Desprez gave potassium iodide subcutaneously, and succeeded in recovering two-thirds of it subsequently from the urine, its earliest appearance in that secretion occurring twenty minutes after the injection. He found that febrile conditions and disease of the kidney delayed the appearance of the salt in the urine, prolonged the period during which elimination occurred, and in the case of Bright's disease, instead of finding two-thirds of the drug in the urine, he found only a quarter, a sixth, and even an eighth (*Lancet*, ii., 1884). Bachrach, giving moderate doses of potassium iodate by the mouth to healthy subjects and to fever patients, traced the drug in the urine of both within fifteen minutes, but on injecting it under the skin, elimination in the former occurred in five minutes, and in the latter forty minutes later (*loc. cit.*). If

¹ Iodine may be detected in any secretions by white starched paper, which should be moistened with the liquid and then touched with nitric acid containing some nitrous acid: blue iodide of starch will be developed. It is used, for instance, to test the delay of absorption in gastric disorders (*B. M. J.*, ii., 1899, Ep.).

tincture of iodine be injected into serous cavities, it passes out of the system as iodide of sodium, never as free iodine or iodate (Anfuso, Rev. Sc. Méd., 1891). As will be noticed again under therapeutical action, iodides have a remarkable power of eliminating with themselves various metals and possibly organic poisons, previously circulating in the blood or deposited in the tissues (by decomposing the albuminates).

PHYSIOLOGICAL ACTION.—*External.*—Locally applied, iodine in tincture, or strong solution, acts as an irritant or caustic. It stains the skin yellowish-brown, permeates and destroys the epidermis, and if it reaches the true skin, causes severe heat and prickling, sometimes vesication (bullous dermatitis *v.* Iodoform), followed by desquamation or superficial scarring.

Volkman and Schede found that a few hours after the application of iodine, the white blood-corpuscles had escaped from the neighbouring vessels to such an extent as to give, under the microscope, an appearance of suppuration; fatty degeneration and disintegration of tissue-elements also occurred, and prolonged applications to the limbs of rabbits caused periostitis.

Iodine like the other halogens has marked antiseptic and antizymotic power; it is fatal to the lower forms of life, both animal and vegetable. It is said that 4 m. of the tincture sterilise a litre of spring water in a few minutes (Meillère, Lancet, i., 1895).

Its vapour, when inhaled undiluted and in sufficient quantity, causes heat, irritation and cough, and sometimes has occasioned bronchitis and hæmoptysis: it is also very irritating to the conjunctivæ. Frictions with potassium iodide sometimes produce local irritation and an acneiform eruption.

PHYSIOLOGICAL ACTION.—*Internal.*—**Mucous Membranes.**—The earliest and most marked evidence of the constitutional action of iodine, whether taken by the mouth or injected hypodermically, is furnished by irritation and catarrh of the mucous membranes. If iodine itself be used, as in the form of tincture, there is more liability to *local* irritation of the mouth and stomach than with the alkaline iodides, but the *distal* mucous irritation is the same with all forms of the drug. It is shown mostly in the throat and bronchi, the nose and eyes—parts that are all exposed to contact with carbonic acid gas, which it is supposed decomposes the iodide as it is eliminated, so that free

iodine exerts its local irritant effect. (It has also been suggested that the decomposition is caused by nitrites present in the blood, and may be prevented by full doses of sodium bicarbonate or by sulphanilic acid, which combine with nitrous acid.) The irritation shows itself by pain and sense of pressure over the frontal sinuses, œdema, prickling, and heat about the nose and eyes, with sense of stuffiness and discharge like that of ordinary coryza. The dose that will produce these symptoms varies a good deal with different persons, some being acutely affected by 1 or 2 gr. of potassium iodide, others not by 10 or even 20 gr. continued daily for a long time; in fact, raising the dose will often stop the symptoms. Ammonium iodide, it is stated, is more liable to cause iodism than the other salts, because it is more easily decomposed in the body.

Circulatory System. — Iodine and iodides, especially the former, stimulate this system, raising the blood-pressure, rendering the pulse fuller and more frequent, dilating the capillaries, and increasing heat in the extremities; from ordinary doses in healthy persons such action may not be noticed, whilst the after-effects of continued doses may be the reverse of these. So much so that Bogolepoff concludes from his experiments that “one of the chief actions of potassium iodide is to lower the pulse tension uniformly throughout the body, by dilating the arterioles, the heart’s action being at the same time diminished in force” (quoted by Balfour, Clin. Lect. Dis. Heart, 1898). With iodoform also, primary stimulation is followed by depression (*v.* p. 114).

Germain Sée discriminates between the action of the potassium and sodium iodides, finding that the former at first quickens and strengthens the action of the heart, raises the blood-pressure and constricts the capillaries, whilst the latter slows the heart—he distinguishes two phases of the action, that of the alkali and of the iodine—and the *final* effect of continued doses of either salt is to *lower* blood pressure (Lancet, ii., 1889). Prévost and Binet state analogous conclusions as to pressure, but find the sodium acts quite like the potassium salt, if given in much larger doses (Rev. Sc. Méd., 1891). The weakening effect on the heart and the lowering effect ascribed to an influence on the central nervous system which are seen in some cases, are probably due to the potassium radicle and not to the iodide as such. In contrast with these observations must be mentioned those recently made by

Professor R. Stockman and Dr. F. Charteris, from which they conclude that iodides of sodium and potassium, in doses of 15 to 40 and up to 300 gr. *per diem*, do not cause any fall in blood pressure or any change in the rate or rhythm of the heart (B. M. J., ii., 1901).

After toxic doses, first palpitation and flushings, afterwards faintness, pallor, and collapse occur, and Benedict concluded, from observations on batrachia, that both cardiac action and respiration were paralysed (Schmidt's Jahrb., Bd. cxv.). A case of this kind is reported by Heller (Wien. Med. Presse, 1887), besides the extravasation of blood, most of the typical symptoms of iodism being present; and a fatal case is reported, from less than 4 gr. every six hours for four days, in a woman of forty-nine (Internat. Journ., 1891).

With regard to the action of iodides on the blood, Sir William R. Gowers remarks that they are credited, he thinks with reason, with the power of promoting coagulation (B. M. J., ii., 1901)—but this seems scarcely consistent with the “iodic purpura,” which has occurred under the potassium salt and has been connected with increased fluidity; its coagulation—*e.g.*, in aneurism—is more probably accounted for by an action of the drug on the vessel walls, and by its reducing the force of the heart's contraction.

Dr. T. C. Fox records an illustration in an adult with syphilide, and convalescent from rheumatic fever. After the second dose of 5 gr., a copious eruption of purpura came out on the arms and legs; this gradually faded and again recurred whilst the medicine was continued. The eruption came again under each of the alkaline iodides, especially the ammonium salt; iodism occurred at the same time, but the syphilide got well: there was no evidence of renal or other organic disease (B. M. J., i., 1879). Dr. Stephen Mackenzie attributed fatal purpura in an infant to one dose of $2\frac{1}{2}$ gr. of the same medicine, but, in this case, the sequence is not so clear as in some others alluded to by him (B. M. J., i., 1878). Dr. G. Thin, after microscopic examination of eruptions caused by iodide, asserts that the neighbouring capillaries are blocked, and their walls altered, but the patient from whom the specimens were taken was syphilitic (Med.-Chir. Trans., 1879). I have myself noticed in several cases that a purpuric eruption has followed the use of potassium iodide. Dr. J. A. Lindsay has recorded a case where, after two doses of $3\frac{3}{4}$ gr.,

this salt caused an eruption scattered over the whole of the cutaneous surface excepting the legs, and consisting of blisters about the size of half-a-crown, which were surrounded by two concentric red rings; a considerable amount of itching was also present (B. M. J., i., 1884). M. Besnier affirms that pure iodine never causes purpura (Annales de Derm. et Syph., t. x.).

Whatever the pathological processes may be, I am satisfied that tincture of iodine is liable to cause hæmorrhage from various organs, especially in phthisical subjects, and in those with uterine congestion. Kness has observed hæmorrhage from the lungs and uterus in poisoning by potassium iodide (B. M. J., i., 1879), and extravasations of blood have been found *post mortem* in animals poisoned by iodoform (Med. Record, 1879). It is stated that when iodine or iodides are given to animals by a vein, they have a special action in causing œdema of the lungs.

Nervous System.—Much disturbance of the nervous system sometimes follows the full action of iodine. It is marked at first by excitement with restlessness, tremor, anxiety, and insomnia, but this state is liable to be succeeded by feebleness and depression; these symptoms are possibly due to increased thyroid secretion. Toxic doses have caused violent headache, and sometimes convulsion (*cf.* Iodoform). Rilliet described neuralgia, tinnitus, disturbed intellect, and convulsions, as prominent symptoms in some cases of iodism. Trigeminal neuralgia has also been reported by others, but lasting for a time only (Lancet, i., 1891). Altered vision and paralysis were noted by Brodie. "Occasional hyperæsthesia and temporary palsy of lower extremities" occurred in a man who was taking very large doses (90 gr. thrice daily) of potassium iodide (S. A. Lane, Lancet, ii., 1873). Such symptoms, however, must be considered rare. H. Wood states that he has only seen the nervous system affected once in his experience, even "with enormous doses," and then the patient, who had been taking 270 gr. daily, became "intensely sleepy and stupid," as if under the influence of *bromide*. Extreme depression is not an uncommon effect of even small doses in sensitive subjects, and sometimes compels the disuse of the drug.

Binz experimented with the *sodium iodate*, and found that in rather large doses this salt caused narcosis in animals. It proved especially poisonous to the respiratory and cardiac centres, and he

suggests that both this salt and iodoform are decomposed, and liberate iodine in the brain and cord.

Digestive System.—Iodine has a pungent taste, and in small doses causes heat and stimulation of the stomach, with some increase of appetite. A dose of more than 1 gr. usually causes sickness, and 5 gr. give rise to salivation, pain in the abdomen, and diarrhœa, though even 15 gr. may be tolerated; large doses may cause glossitis, local inflammation, and ulceration. Vomiting, burning pain, spasm, choking sensation, and impairment of the special senses were symptoms noted by Mr. Bainbridge, after taking 1 oz. of tincture of iodine, B. P.; oil was given, and recovery occurred gradually (Lancet, ii., 1875).

The alkaline and other iodides have a bitter, saline disagreeable taste which is apt to remain long in the mouth; they readily disorder the stomach in many persons, and though at first they may increase appetite, they afterwards impair it. Small quantities are apt to constipate, but if continued they produce diarrhœa with liquid, slimy stools. At times, gastric irritation and catarrh are the only marked symptoms of iodism (Rilliet); large doses seem often better borne than small ones.

Rabuteau points out that either iodide or iodate separately is unacted upon by weak hydrochloric acid, whilst their mixture is quickly decomposed by it with liberation of free iodine; also, if fresh gastric juice be mixed with starch in test tubes containing the one iodide, and the other iodate, no blue reaction occurs till the contents of the two tubes are mixed, implying that free iodine is the irritant agent in the impure salt, and that a pure alkaline iodide is non-irritant. Practically, however, I am satisfied that as pure an iodide as is obtainable will produce gastric irritation in some subjects. In the case of all iodine compounds, such irritation may be avoided or lessened by giving them freely diluted, and shortly after food; though some say that the mucus of the fasting stomach is a better protection, and Gardner's syrup of hydriodic acid is better taken before food; it is said not to irritate, and that is my own experience.

Lymphatic System.—The drug increases the activity of the lymphatic system, largely because of the fact that certain kinds of tissue are broken down and rendered more susceptible of absorption. The iodine set free from any iodide is taken up by

albuminous substances, and the entrance of the iodine molecule into their composition causes them to undergo more rapid metamorphosis. This explains the action of the drug in causing absorption of gummata and inflammatory deposits; and gives a reason for its usefulness in tuberculous conditions, associated with enlargement of lymphatic glands, thyroid, and spleen.

Schleich and also Heinz have found, independently, that potassium iodide both increases the formation of leucocytes and their determination to any wounded or ulcerated place; at the same time they corroborated the observation of Binz, that iodoform, *i.e.*, free iodine, lessened the migration of leucocytes (Rev. Sc. Méd., 1891).

The secretion of the salivary glands, of the pancreas, and, possibly, of the lachrymal glands and of mucous membranes and the testes, is increased by it. Rutherford concluded that the bile was not affected in quantity (B. M. J., i., 1879).

The secretion of milk is lessened under the influence of iodides, and may be almost wholly prevented by small doses commenced soon after delivery. If already established it may be suppressed by the same treatment if the infant be not placed to the breast (Morris, Lancet, ii., 1864). There are, however, some observations to the contrary, *e.g.*, those of Lazansky (Med. Record, 1878), who states that iodine does not affect the secretion, and certainly it may be given to syphilitic nursing mothers without stopping the flow of milk when this has been established for several months. Dr. Dolan also concluded that potassium iodide failed to stop the secretion, but the balance of recorded evidence is that 5 or 10 gr. doses will do so.

Whether iodine can cause atrophy of true glandular structure is an important question which is not yet decided in the affirmative, though Rilliet accepts its truth in the case of the testes and mammæ. Others state that it has occurred only in cases of goitre when the thyroid has been diminished by a course of iodides, and Lebert suggests that the gland-atrophy results from absorption of thyroid secretion. Moisisovitz states that iodine has this effect (atrophy), but not the iodides; he refers to 800 patients (Canstatt, Jahresb., 1866): certainly large quantities have been given without any such occurrence. Rabuteau gave to a woman, in the course of six years, 3 kilogrammes of potassium iodide, yet the breasts were

not at all affected by it, and Velpeau never observed wasting in 15,000 cases treated by him (*Med.-Chir. Rev.*, ii., 1860). On the other hand, one case of wasting of the testes is recorded, but it is not convincing (*Philad. Med. Times*, iv.). An enlarged and hard gland will grow less under these remedies from absorption of hyperplastic material, and even a healthy gland may grow smaller from absorption of fat or epithelial products, but so far as I have seen, the breasts, etc., recover their natural appearance on omission of the remedy, which they would not do if the gland-structure were actually destroyed.

Cutaneous System.—Besides the purpura already mentioned, various forms of skin-eruption may follow the internal use of iodine or the iodides, the most usual being allied to acne in appearance, and (according to T. C. Fox) in pathology also, that is to say, connected with irritation of the sebaceous glands. I have seen the rash differ greatly in appearance.

The ordinary rash is at first papular and then becomes pustular, and affects especially the face, head and back; sometimes an erysipelatous blush is produced, sometimes bullæ, ecthyma, or anomalous pustules (Hutchinson). An interesting case of "dermatitis tuberosa" affecting the nose is recorded by Dr. Walker, from Unna's clinique; he adds also, urticarial, pemphigoid, anthracoid and nodular, to the various forms described above as occasionally due to iodides (*Lancet*, i., 1892; *cf.* *N. Y. Med. Journ.*, Nov., 1888—Dr. Taylor's case): good illustrations are in Dr. Crocker's Atlas. Edema of the eyelids sometimes occurs. The irritant effect upon the skin may be much controlled by small doses of arsenic, and by scrupulous cleanliness: it cannot be taken as an index of the physiological or therapeutical action of the drug.

Genito-urinary System.—The genital system is said to be stimulated by iodine (Jörg); an increased flow of blood to the uterus is sometimes produced by it, and abortion has been attributed to full doses. If the potassium iodide has a similar effect it is much less in degree; in fact, this drug is usually regarded as anaphrodisiac.

The effect of these preparations upon the urine is variable. Begbie speaks of potassium iodide as one of the best diuretics (*Lancet*, ii., 1875), whilst Dr. Handfield Jones, out of six cases observed, found the secretion increased in three, but diminished

in two (Beale's Archives, No. 3): similar variation has occurred in the uric acid and urea. Rabuteau observed no diuresis from 15 gr. doses. Wöhler, giving iodine to a dog, noted increase of urination, but only in proportion to increased quantity of water drunk. Bassefreund, from observations on himself, concluded that the urine in healthy persons was not augmented under iodides; at first, it was rather lessened in quantity (Canstatt, Jahresb., 1859). Very large doses may irritate and congest the kidney, and induce albuminuria, in which case the amount secreted would naturally be lessened (Gubler). Dr. Simon found that albuminuria occurred in the majority of children who had tincture of iodine externally applied, whether to the scalp, the chest, or the knee (B. M. J., ii., 1876), although from the analyses of Dr. Ord in a case of iodine poisoning, the urinary precipitate in such cases would seem to be mucin rather than albumin. As remarked by Sir Spencer Wells, the alkaline iodides have some power of dissolving uric acid, but this is due probably to the alkali rather than the iodine. In Dr. Ord's case, urea and uric acid were largely *increased*. In diabetics taking iodide, the same thing occurred (Bouchardat).

On the other hand, Rabuteau, taking daily, for five days, 15 gr. of potassium iodide, reported marked *diminution* in his excretion of urea to the extent, some days, of 40 per cent. during the period of experiment, and for nearly a fortnight afterwards.

Influence on Nutrition.—From these discrepant results, it becomes difficult to theorise concerning the action of iodine on nutrition, and further reliable analyses of the excretions under its use are desirable. The French physiologists concluded that its influence resembled that of arsenic, *i.e.*, had more of an alterative and modifying than of an absorbent and eliminant character. My observations lead me to place more stress upon the latter. Although the medicinal use of iodides in some disorders may bring about an improved state of the nutrition (Wallace found, for instance, that his syphilitic patients gained flesh under its use), yet, when given continuously to persons of average health, these medicines usually impair nutrition, and induce more or less emaciation. Dr. Mitchell Bruce states that it accelerates tissue change without increase of urea, or bodily wasting, and suggests metabolism of plasma rather than of the tissues themselves.

Samoilow has shown, by numerous observations on animals, that potassium iodide given in small doses promotes assimilation, whilst large doses have an opposite effect (*Internat. Journ.*, 1887). According to Högyes and Binz large quantities of iodine, potassium iodide and iodoform cause fatal poisoning in lower animals, with extensive fatty degeneration.

Idiosyncrasy.—Toleration.—There is much difference in the susceptibility of persons to the action of iodine, and we can explain this in no better way than as “idiosyncrasy.” According to Seguin, children are usually more tolerant than adults in proportion, and cerebral and cardiac cases usually less so (*Lectures*). Speaking generally, it may be said that pale, thin, languid patients often bear it better than the stout and plethoric. Such subjects, if rheumatic, are often intolerant of even small doses; so are the sufferers from exophthalmic goitre, or nervous palpitation accompanied with irregular flushing and impaired vasomotor power. In such cases small doses ($\frac{1}{2}$ gr.) often produce as beneficial results as large ones do in persons who are but little affected by the drug.

Climate and soil seem to exercise some influence, for Coindet’s patients, in Geneva, were much more susceptible than those of Ricord, in Paris (*Med.-Chir. Rev.*, ii., 1860). Dr. Lisson concluded that people with fair skins were more susceptible to the action of this, and all other drugs affecting the skin, than dark subjects, and this may prove some guide. He himself was able, by commencing with small doses, to induce a state of toleration, so that he could take 100 gr. of potassium iodide without marked effect (*Lancet*, i., 1860). Mr. Arthur Cooper states that the largest amount he has given in the day was 540 gr. of the ammonium iodide, and he mentions no bad effects from it (*Lancet*, i., 1885). On the other hand, 3 gr. doses have caused severe inflammatory attacks (*Lancet*, ii., 1873), and even a less quantity may excite distressing coryza. Bad effects may, however, be often avoided by following Lisson’s plan, and inducing tolerance, *e.g.*, I gave a patient with syphilis, potassium iodide in 3 gr. doses thrice daily, but he always suffered from coryza and headache after two or three days; then it was reduced to 1 gr., and the same results followed; then he took $\frac{1}{2}$ gr. thrice daily without ill effects, and the dose was gradually increased, till in a few weeks he

was able to take 15 gr. three times daily. Another method is that of Hynson, who makes up an aqueous solution containing 1 grain per minim, and begins with a few minims largely diluted with milk or water and increases gradually up to many drachms daily, if necessary (Philad. Med. Journ., 1899). In one case, iodism setting in after the fourth dose of 3 gr. of potassium iodide affected the larynx so intensely as to require tracheotomy (Lancet, ii., 1875), and Fournier reports two fatal cases of œdema glottidis due to potassium iodide (Gaz. des Hôp., 1889), while Rosenberg has also seen œdema of larynx (Deut. med. Woch., 1890). Other cases of œdema glottidis lead to the conclusion that this symptom is due to idiosyncrasy and not to impurity in the drug or to disease in the larynx (B. M. J., i., 1890). *Acute* iodism is generally proportional to the largeness of the dose; but the *chronic* condition is more readily induced by continued small doses. The sodium iodide is often, although not always, better borne than the potassium salt, while the ammonium iodide, owing to its instability, is apt to disagree, but strontium iodide seems to have advantages over all these (although I have seen five cases of iodism from strontium iodide, I have not seen it from the hydrogen compound).

SYNERGISTS.—The stimulant action of iodine is increased by warmth, alcohol, ozonic ether, the essential oils, etc. Ammonia especially has been found to assist its effect and enable it to be borne, either by chemical combination with it, or by bringing about free circulation in the skin.

The absorbent effect is remarkably aided by the simultaneous use of mercury, and *vice versâ*.

ANTAGONISTS AND INCOMPATIBLES.—Cold, quinine, the alkaline bromides, and other sedatives to the circulation, moderate or antagonise in part the specific action of iodine; this fact, however, does not prevent its combination with those drugs for therapeutical purposes. Starch and albuminous substances are the best chemical antidotes to iodine in cases of poisoning: if taken by the stomach, that viscus should be washed out and the bowels emptied—soda salts should also be given—stimulants to the heart and respiration may be required.

There is clinical evidence that belladonna will lessen the catarrh of iodism, perhaps by lessening saliva and the decomposition of the salt (Lancet, ii., 1895); morphine will also do so (Lancet, i.,

1896, and Semaine Méd., 1896, No. 18): arsenic lessens the skin eruption as in the case of bromides.

Carbolic acid and liquor ammoniæ, also liquor calcis chlorinatæ, enter into combination with the drug, and remove its brown colour, but are said not to lessen its active properties. I have not, however, obtained as good curative results in absorption of glandular tumours from the ammoniated iodine—which is mainly an iodide of the alkali—as from the pure drug. Bismuth subnitrate, which is sometimes prescribed with the potassium iodide, precipitates an insoluble red iodide of bismuth. If calomel be applied to the eye while potassium iodide is being taken internally, red iodide of mercury is formed locally and may irritate the conjunctiva severely. The organic alkaloids, strychnine, atropine, etc., are precipitated by iodine—according to Dr. Fuller, $1\frac{1}{2}$ gr. of strychnine by 1 dr. of tincture of iodine; hence he and other observers have thought them mutually antidotal, but the compounds formed are themselves poisonous (Med. Times, i., 1861; Lancet, i., 1868), and require removal from the stomach as much as the original poison (Lancet, i., 1876). With regard to the asserted incompatibility of quinine and iodides, no doubt the direct combination of full doses is apt to disagree and to cause sickness (B. M. J., i.-ii., 1884), but if the quinine be first dissolved in a little hydrochloric acid, or better, in glycerin, ordinary doses are usually well borne. Brunton notes a “persistent bitter taste” from the mixture, not experienced from either drug separately, and thinks it due to the iodide promoting excretion by the saliva.

The iodide of starch may be antidotal to sulphides and to caustic alkalies, as stated by Bellini.

THERAPEUTICAL ACTION.—*External.*—Iodine is used (both alone and combined with potassium iodide or with camphor) in tincture, liniment, and ointment, as a mild stimulant, or strong counter-irritant, or caustic, according to the strength of the application. It causes pain when applied freely, and in children, and delicate tuberculous subjects, should be used with special caution.

Tuberculous Glands.—“Iodine paint” is a common and often a useful application to enlarged and hardened glands in the neck, groin, etc.; but sometimes the constant application of iodine lotion

($\frac{1}{2}$ oz. of tincture to $\frac{1}{2}$ pint of water) gives a better result, and is less painful. Mr. F. Jordan recommends painting iodine not *over* but *round* the enlarged glands, and this is sometimes more advantageous.

If suppuration has occurred, the tincture should be painted over the neighbouring thin skin; and if the open sore remain indolent, it should be dressed with iodoform ointment, or with a solution of about 2 dr. of tincture in $\frac{1}{2}$ pint of water, and applied on lint covered with oiled silk. In certain chronic glandular enlargements, the direct injection of iodine tincture acts better and more quickly (Bradley, *Lancet*, ii., 1875). Mr. G. Morgan however finds that this "old method spoiled the syringe, injured the child, and damaged the surgeon's reputation," and has drawn attention to the importance of ascertaining which region and which surface, mucous or cutaneous, is drained by the enlarged gland or glands, and then applying the iodine to that surface as well as to the glands, *e.g.*, the glands at the angle of the jaw and the upper deep cervical drain the tonsil, therefore the remedy should be applied to it, *i.e.*, the tonsil. He uses a solution which is similar to Mandl's, *viz.*, Iodine 12 gr., Pot. iod. 15 gr., Ol. Ment. pip. m̄ii, Glycerin 3i (B. M. J., ii., 1899).

Enlarged Tonsils, etc.—These are often connected with the strumous diathesis, and iodine tincture is one of the best local applications, though it is an unpleasant one, and sometimes excites irritation. After some absorption has occurred, I follow its use with the solution of perchloride of iron. In obstinate cases, a few drops of tincture of iodine have been injected into the substance of the tonsil with good result. The internal use of the drug in small doses, or of iodides and cod-liver oil, is desirable at the same time. In follicular tonsillitis, "sore throat" or spots of ulceration about the buccal mucous membrane induced by cold, and in subacute and chronic stages of the former, a paint containing the tincture with glycerin of tannin is often useful.

Bronchocele.—In cases of fibrous and fibro-cystic bronchocele where calcareous degeneration has not occurred, local applications of iodine should be combined with its internal use. If the part be tender or inflamed, soothing fomentations, or even moderate leeching, may be needed before using iodine; then either the solution or ointment may be used once or twice daily for several days,

according to the degree of irritation produced, or an iodised collar may be worn (made with iodine sprinkled on wool), or iodide of mercury ointment may be rubbed in (*v. Mercury*). I have sometimes been disappointed with the mere external use of iodine in bronchocele, but have had excellent results from its *injection* into fibrous and fibro-cystic cases (25) in which I have used it. In one large fibro-cystic growth, in which there was some difficulty of diagnosis, no fluid being suspected, 30 min. of the tincture were injected, and considerable diminution of the growth followed: a month afterwards 3 oz. of fluid were drawn off, and the cyst injected with 2 dr. of a solution containing 1 part of tincture to 3 of water. The man was tuberculous and the growth was of long duration; but after the inflammatory condition set up by the iodine had subsided, the bronchocele disappeared and gave no further trouble. The only case in which complications occurred was one in which some iodine solution had escaped into the cellular tissue, and sloughing of the part followed. Nineteen out of the twenty-five cases got well, two of them having been injected seven times. Dr. Lücke, of Berne, has reported equally good results in the fibrous form of enlargement. Of sixteen cases treated by him, eleven were cured and four improved; and Sir Morell Mackenzie, who at first considered this method inferior to others, recorded his later experience of it as very favourable. He obtained unexpected cures in fibrous and adenoid cases from the weekly or bi-weekly injection of 30 drops of the tincture (*Med. Times*, i., 1872; *B. M. J.*, ii., 1873). Dr. Luton speaks well of similar injections of iodic acid—1 part to 5 of water,—about $\frac{1}{2}$ dr. at one time (*Lancet*, ii., 1873). Evidence both for and against parenchymatous injections of iodine in goitre has accumulated since my last edition, but the balance is still favourable, though possible danger must be recognised. Whilst Scopari, Tivy, and others have reported excellent results (*Med. Record*, 1883-85), Sir Felix Semon, Wörner, and others have drawn attention to cases where serious and even fatal consequences have followed (*B. M. J.*, i., 1885; *Record*, 1885). The latter concludes, however, that the operation is feasible, if the innervation of the larynx is unimpaired. The treatment of goitre by potassium iodide, together with local application of cold by Leiter's tubes, has also been advocated (*Record*, 1884) (*v. Iodoform*, p. 118; also *Internal Use*).

Orchitis.—Prostatitis.—Mammary Growths.—If hardness and swelling of the testicle remain after subsidence of the acute stage of inflammation, iodine lotion or ointment, with strapping, will prove effective.

In subacute and chronic enlargement affecting the prostate gland, I have seen much advantage from iodine suppositories, and still more from iodoform ointment. In cases of chronic enlargement, Heine has injected the tincture into the substance of the gland with successful results (*Med.-Chir. Rev.*, i., 1873).

Congestions and localised hardness and obstruction of the mammary ducts are amenable to iodine frictions, but the skin of the breast is very sensitive and easily irritated.

Pleuritis.—Phthisis.—The external use of iodine will frequently relieve subacute pleuritic pain and the “flying” chest-pains which are common in phthisis. In chronic pleuritis with effusion, iodine applications have some power to promote absorption; and in phthisis and chronic bronchitis painting it over the front of the chest serves to impregnate the air which is breathed, and modifies expectoration and the state of the bronchial mucous membrane. Inhalation of iodine may also be practised, and a few grains may be left exposed in the sick room with advantage. Fœtid organic odours from the breath, etc., are lessened by it.

The external use of iodine, combined with pressure, aids in the absorption of effusions, and some surgeons have, in chronic cases, injected into and retained a weak iodine solution (4 or 5 gr. to the pint) in the pleural cavity, with ultimate success. It seems to be, however, an operation of unusual risk, and one which has been followed, more than once, by death from inflammatory reaction, embolism, or shock (*v. Empyema*).

Diphtheria.—I have found an iodised spray or inhalation often useful in this malady. A good formula is one containing 4 gr. each of iodine and iodide of potassium in $\frac{1}{2}$ oz. alcohol and 4 oz. water. Of this one to four teaspoonfuls may be added to a pint of boiling vinegar or water, and the vapour inhaled every two hours from five to ten minutes, or the plain tincture may be painted on and inhaled (*B. M. J.*, ii., 1900).

Chronic Peritonitis, etc.—In this malady, especially when occurring in tuberculous subjects, and accompanied with enlarged

mesenteric glands, the external use of iodine in the form of ointment, liniment, or compress, should be conjoined with internal treatment or injection: in cases of chronic congestion of the liver and spleen the external application of iodine is useful. Some remarkable results have been recorded from the subcutaneous injection of $\frac{1}{6}$ to $\frac{1}{2}$ gr. of iodine in an iodide solution, which is quite safe, though painful; chronic exudative and tubercular cases—six—are said to have been cured in one to two months (Biagi, *Gaz. deg. Osped.*, Dec., 1900; and B. M. J.).

Uterine Congestion, etc.—In congestive enlargement of the uterus, with some induration of the cervix connected with subinvolution or chronic inflammation, benefit may be derived from iodine locally applied. Tepid injections containing 1 to 2 dr. of the tincture in a pint of water, and also iodised hip-baths are useful. Dr. Greenhalgh prepared an “iodised cotton” by saturating 8 oz. of cotton in the same quantity of glycerin, containing 1 oz. of pure iodine and 2 oz. iodide of potassium, and kept a pledget of this pressed for some hours against the cervix, withdrawing it when necessary by a thread secured to it. Dr. Graily Hewitt applied the tincture directly to the inflamed part, and recommends this treatment especially for patients of sluggish habit and scrofulous diathesis. My own experience of it in similar cases is favourable. Dr. James Bennet recommends direct injection of an iodised solution in chronic cervical metritis (*Dub. Med. Journ.*, Oct., 1878). In cases of granular erosion and ulceration, the iodide of silver, prepared extempore as recommended by Dr. Wright, by adding a few drops of iodine tincture to some nitrate of silver solution, may be used with much advantage. In amenorrhœa dependent upon torpor of the uterine system, local applications of iodine are useful.

Menorrhagia.—In persistent cases Dr. Savage, and Dr. Routh, have used intra-uterine injections of iodine (*Lancet*, ii., 1851; *Med. Times*, i., 1860), but this treatment involves too much risk for ordinary use. In chronic uterine leucorrhœa Dr. G. Murray applied the remedy by means of a sound, which is safer than injection (*Lancet*, i., 1866). In the ordinary form the injection of a solution of iodine, 1 dr. of the tincture to a pint of warm water, or painting the tincture over the vaginal wall, is a useful remedy.

Gonorrhœa.—Gonorrhœal attacks in females can sometimes be cut short by one or two paintings of the vagina, cervix uteri, labia, and urethral canal with strong tincture of iodine, after first cleansing away the discharge. The pain lasts for some hours, but the result usually is good.

Injection of Cysts.—**Hydrocele.**—The injection of iodine in cases of hydrocele gives better results than any other remedy. The serous fluid should first be evacuated thoroughly, and then 1 to 4 dr. of iodine tincture injected (according to the size of the cyst). Sometimes inflammatory reaction occurs, and lasts two to six weeks, but the ultimate result is usually good. I have seen one case of fifteen years' duration, where the scrotum hung nearly to the knees, and was supported by a sling round the neck; after puncturing and evacuating, 6 oz. of iodine tincture were injected: the physiological effects were strongly developed, but complete cure followed. I believe that Sir Ranald Martin introduced this method of treatment, but he diluted the tincture with two parts of water. Mr. Furneaux Jordan has advocated the use of two or three threads soaked in the tincture and drawn through the hydrocele, to act like a seton (*Lancet*, i., 1876).

Spina Bifida.—I have not myself had much experience recently in the use of iodine in this deformity, and what I had in former years was not favourable; but the results of Dr. Brainard, Dr. Morton of Glasgow, and others, have placed the operation on a new basis. The cases were not simply those in which connection with the spinal canal was naturally obliterated, and which might fairly be expected to recover, but included some of much more serious nature. In the majority, not only was the sac obliterated, but improvement as to paralysis and general health occurred. The solution used ("Morton's solution") was—"iodine 10 gr., iodide of potassium 30 gr., glycerine 1 oz.," and of this $\frac{1}{2}$ to 1 dr. was injected after removal of more or less fluid according to the case (*Lancet*, ii., 1876).

Dr. G. W. Thompson records an instructive illustration, in which the tumour over the sacral region was twelve inches in circumference ten days after birth; it was attached by a pedicle and communicated with the spinal canal: after tapping and removing about 2 oz. of fluid, 25 min. of Morton's solution were injected and the aperture sealed. There was much shock, and brandy was

given freely; gradual improvement, however, took place, and six months afterwards only a mass of thickened skin remained (B. M. J., ii., 1878).

Mr. Pearce Gould has recorded the case of a child, aged eighteen months, with a sessile tumour, as large as a cricket ball, situated over the last lumbar and sacral vertebræ, and communicating with the spinal canal. At the first operation 6 dr. of fluid were drawn off, and $\frac{1}{2}$ dr. of Morton's solution injected; at the second operation 1 oz. was removed and 1 dr. injected; at a third, $2\frac{1}{2}$ oz. removed and 2 dr. injected. There was neither shock nor convulsion; improvement set in on the ninth day after the last operation, and ultimately only a flat mass of dense tissue remained: there was no paralysis (Clin. Soc. Trans., vol. xi.), but in other cases paralysis has occurred (B. M. J., i., 1886).

A committee of the Clinical Society (Trans., 1882) considered Morton's the best method, notwithstanding its many failures, but they recommended a careful selection of cases. Marasmus, hydrocephalus, and intercurrent disease contra-indicate the operation. The best result is to be hoped for in children who have reached the age of two months, in whom there is no paralysis or hydrocephalus, and when the sac is covered with healthy skin. In cases in which the operation may be legitimately performed, the following were stated to be unfavourable circumstances: (1) evidence of the cord being in the sac; (2) a very thin, membranous, ulcerated, or previously ruptured sac; (3) the occurrence of a distinct impulse between the tumour and the anterior fontanelle, or a sac, the contents of which are easily returned into the spinal canal; and (4) a very early age of the patient.

Hydrarthrosis.—In extensive chronic serous effusion in the knee-joint, injection of iodine has frequently led to cure. One part of iodine, 2 of iodide of potassium, and 8 of water, are injected in about the same quantity as is withdrawn by aspiration; air should be carefully excluded from the wound. Mr. C. Macnamara has injected 1 oz. of the pure tincture with satisfactory results (Lectures, 1881). In less severe cases, in bursal effusions (housemaid's knee), and in rheumatic and gouty joints, the external application of iodoform, or iodine paint, promotes absorption, and should be tried before puncture; or lotion containing $\frac{1}{2}$ oz. of tinctura iodi in 6 oz. each of glycerin and water, may be applied

on lint covered with flannel; frictions and douches should be combined with this treatment.

Empyema.—In chronic cases, provided a free opening is secured, an iodine injection (1 to 2 dr. of tr. in the pint) is sometimes serviceable, both to disinfect and to stimulate healthier secretion and contraction of the cavity. Dr. Dickinson speaks of it as better than any other treatment (B. M. J., 1876). On the other hand, I have known it excite much undue irritation, both local and systemic. In some cases, sudden, or threatened death has followed the injection of iodine solutions into the pleural cavity, but we cannot reasonably attribute the result to iodine, because in the same cases iodine had been previously used without harm, and besides, sudden death has followed, in a similar manner, the injection of warm water, of carbolic acid lotion, etc. The effect may have been connected with mechanical conditions, such as insufficient freedom of exit or too great pressure of fluid, or with special cardiac conditions of feebleness, dilatation, etc., but, certainly, I am of opinion that injections into the pleural cavity are not without some risk; they should be abandoned in favour of free drainage with strict antiseptic precautions. This change in practice has become much more general since my last edition.

Pericardial Effusion.—I have treated several severe cases of this condition by iodine injections: for instance—(1) G. H., aged thirty-seven, had in youth two attacks of rheumatic fever, with endocarditis of aortic valves: when otherwise robust, a third attack came on in August, 1876. In November, when I first saw him, there was extensive pericardial effusion, with bulging and fluctuation; cardiac dulness extended beyond the right of the lower sternum, and upwards as high as the second rib; the heart-sounds were feeble and indistinct, and the respiration impeded; there was a short dry cough, and extreme orthopnoea, so that life was in imminent danger. I drew off 3 oz. of fluid, and injected 10 min. of tincture of iodine; relief was experienced, and I repeated the operation in forty-eight hours. After this the man gradually recovered, though eight months afterwards he died suddenly from his aortic disease. (2) In another man, aged twenty-three, also suffering from extensive pericardial effusion, with intense dyspnoea and other urgent symptoms, 2 to 3 oz. of fluid were drawn off by aspiration; much relief was experienced,

and 10 min. of tincture of iodine were then injected. Thirty hours afterwards, 10 min. more were injected; no symptoms of iodism appeared, and the patient made a good recovery. In both cases 4 to 6 gr. of iodide of potassium were taken with bark thrice daily, before and after the operation.

Abdominal Cysts.—The following case, which occurred in my practice some years ago, will illustrate some of the risks and the possibilities of treating large cysts by strong iodine injections. A gentleman, aged seventy, had an enlargement of the abdomen which was obscure in its nature, and was diagnosed as dependent on a cystic or solid growth from the under surface of the liver. Attacked one day with rigors and sudden, violent pain, he became jaundiced and collapsed, and when seen by me was semicomatose and apparently dying. Some obscure fluctuation being detected in the enlargement, a trocar was inserted, and 21 to 23 pints of thick grumous fluid, with some pus, were drawn off; this was examined without detection of hooklets. Three weeks afterwards, 16 pints of fluid were drawn off, and 16 oz. of pure tincture of iodine (B. P.) injected, allowed to remain for twenty minutes in the sac, and then some of it to escape. Severe effects soon followed the injection—salivation, soreness of the mouth and throat, sickness, eructations, headache, giddiness, etc., accompanied by palpitation and pyrexia: the pulse was 140, weak and irregular, the temperature 101.8° F. Epistaxis occurred twice, and frequent thin watery stools were passed. Later temperatures varied from 101° to 104° F., and the pulse from 110 to 140. Pains in the limbs and in the loins set in, and also in the long bones (due to periostitis); the urine became scanty and blood-stained, and both it and the saliva contained large quantities of iodine. The salivary glands were painful and swollen, and the palate and fauces sore and inflamed; there was constant short dry cough with more or less aphonia.

Severe symptoms continued until the fourth day, when an eruption, somewhat like measles, appeared, with apparent relief, and by the ninth most of the other symptoms had disappeared. Iodine was, however, excreted by the urine for about sixteen days, and albumin for twenty-five days, convalescence progressed favourably, and the patient lived for two years afterwards, dying from the effects of a large cholesterin calculus in the gall-bladder.

Ovarian Cysts.—Formerly, when the cyst was unilocular, and no acute symptoms were present nor active growth going on, the injection of iodine was sometimes used, but the radical operation of removing the diseased ovary has now such a constant success that the uncertain method of injection is seldom employed, and is objected to as leading to adhesions which complicate the operation. M. Boinet recorded forty-five cases, treated by tapping and injecting equal parts of tincture of iodine and water, allowing this to remain for a few minutes, whilst the abdomen was gently manipulated, then to escape; thirty-one out of these cases are said to have been successful, whilst nine ended fatally.

Velpeau, Simpson and Spencer Wells obtained what were considered to be favourable results with the same method (*Med. Times*, ii., 1860), but Tyler Smith succeeded in only two out of ten cases in which he employed it, and of six patients treated by Schuh only one was cured and one relieved. My own experience of injection in ovarian cysts, though not large, is as follows. In one case, now twenty-six years ago, I withdrew a pint of fluid from a large cyst, and injected 4 oz. of tincture of iodine, and after repeating this three times absorption ultimately took place, and the lady, now living, had no further inconvenience. In another similar case, in which I drew off a pint of fluid and injected 2 to 3 oz. of tincture of iodine, severe physiological effects followed, and continued for ten days; but the patient soon rallied, and three months afterwards 4 oz. more were injected, and absorption of the cystic fluid rapidly took place: this was in 1864, and at the present time there remains only a growth the size of an orange, which gives rise to no annoyance.

In both cases the cysts were unilocular, and were of some years' duration, but the operation, though favourable in result, required repetition, and produced for a time troublesome symptoms. It is clearly not one to be adopted without much consideration, and only for cases such as those described, where the patients would not submit to removal of the ovary. Sometimes a fatal issue has followed directly from an iodine injection (*Virchow's Archiv*, Bd. xxxv.).

Ranula.—It has been recommended to inject the sac of a ranula with iodine after emptying its contents; I have made numerous trials of this plan, but have abandoned it as unsatisfac-

tory. I used it three times in one case, but with no other result than to cause much irritation; cure was ultimately obtained by dilating the duct-aperture with laminaria.

Abscess Cavities, etc.—The injection of iodine has been resorted to, and sometimes with success, for the purpose of disinfecting such cavities and controlling the secretion of pus.

Boinet gives the history of a chronic abscess occupying the whole right iliac fossa; it followed a bubo, and discharged profusely by a fistulous tract. After many months of unsuccessful treatment by injections, ointments, nitrate of mercury, potash, compression, etc., he injected a solution of iodine (2 dr. of tincture in 4 oz. of water) to the bottom of the cavity through a catheter; much pain followed and afterwards severe febrile reaction, but in about a fortnight a radical cure was obtained. Such successful results cannot be always depended upon, and, in fact, I have known injury from this mode of treatment in many such cases; for instance, in one case of psoas abscess 1 dr. of tincture in 3 oz. of water was injected three times in a fortnight, but considerable irritation and increase of hectic fever were set up without subsequent improvement; after an interval of four months it was repeated (1 dr. in 4 oz.), but with the same result, and the patient died shortly afterwards, when vertebral caries was found.

In another similar psoas abscess, where the malady was not recognised until an opening in the groin had nearly occurred, iodine was injected, and induced much hectic and aggravation of symptoms; no improvement could be traced to repeated injections, but the patient is still living. In smaller abscesses I have found the injection of iodine beneficial; it offers less risk than in large psoas abscess, and is more likely to succeed. Mr. Stirton found it answer well in a chronic scrofulous abscess of the groin—he used 2 gr. to 1 oz. of water (*Med. Times*, ii., 1870).

In ulceration about the mouth and tonsils, and in the severe form called “*cancerum oris*,” touching with strong iodine solution is often curative.

Fistula.—Hæmorrhoids.—In some cases, iodine injection is said to have answered well. Lachrymal fistula has been cured by it (*Lancet*, i., 1874), also congenital branchial fistula (*Med. Record*, 1879). In rectal fistula an ethereal solution has been of service (*Lancet*, ii., 1872), but should not be allowed to remain in

the bowel as it may cause severe pain (Med. Times, i., 1860). A good colourless disinfectant and cleansing lotion for such cases is made with tinctura iodi ʒiiss, glycerini ʒij, liquor calcis chlorin. ʒvi; use $\frac{1}{2}$ oz. to 6 or 8 oz. of water (Dr. Boggs). Mr. Stirton has related a case of rectal fistula in which the ordinary operation had failed several times, but succeeded when iodine injection was commenced immediately after it. In my experience, I have never known iodine by itself cure anal fistula, and should always recommend an operation in preference to injections of any kind. Iodised injections are, however, often useful in stimulating old atonic sinuses in the neighbourhood of joints, etc. Prolapsed, inflamed piles may be successfully treated by painting lightly with tincture of iodine once daily.

Gingivitis.—"Tartar."—The local application of tincture of iodine will usually cure inflammation, sponginess, or tenderness of the gums, and will soften deposits of "tartar," so that they may be removed with the brush.

Purulent Ophthalmia, etc.—M. Boinet relates a severe case of double ophthalmia and scrofulous catarrh, which had lasted for thirteen months when admitted into the St. Louis Hospital, but in a few weeks was cured by the constant employment of an iodine lotion and nasal injection. I began to use this treatment in such cases many years ago, and have often had excellent results. In ulceration about the cornea, and in granular lids, iodine tincture, and solution of iodic acid, 1 to 2 per cent., are good applications; and the liniment, painted round the eye, relieves the photophobia so frequent in tuberculous children (Amer Journ., ii., 1900).

Catarrh.—The vapour given off by powdered camphor sprinkled with tinctura iodi has been found effective for arresting coryza (Med. Times, i., 1874); and inhaling from pure iodine, or carbolate of iodine, is also commended.

Ozæna.—This condition may be relieved by irrigating the nose with salt solution to which a few minims of tincture of iodine have been added.

Erysipelas.—Several authors concur in stating that the local use of iodine tincture will relieve this inflammation. Lanyon relates a case of the idiopathic form, affecting the right side of the face and rapidly extending. The tincture was painted over

and beyond the inflamed part; within four hours pain was relieved and sleep obtained; the malady did not advance, and, after another application next day, convalescence set in. Boinet records two cases of "traumatic" erysipelas—one connected with suppurating wounds in the perineum, and affecting the right thigh, the other starting from a varicose ulcer, and affecting the whole leg; thorough application of tincture of iodine, once daily for three days, rendered the wounds healthy, and controlled the inflammation and swelling. Dr. Davies advocates the same remedy used rather stronger (40 gr. iodine to 1 oz. alcohol). It probably acts, like other irritating substances in erysipelas, by setting up a zone of inflammation which limits the spread of the erysipelatous patch, but its local antiseptic action may also be of value.

Burns:—Chilblains.—In burns of the first degree and unbroken chilblains the pain, itching and irritation may be relieved by tincture of iodine, or ointment. "Coster's paste" is a good form and consists of a solution of 1 part of pure iodine in 4 of "colourless oil of tar." It requires to be mixed carefully, for heat is developed during the process: the resulting liquid is thick and dark coloured.

Lupus.—In erythematous lupus, and in early stages of the tuberculous forms, strong iodine paint is sometimes useful; equal parts of pure iodine and iodide of potassium, in 2 parts glycerin, may be used twice weekly; this excites "substitutive irritation," and exerts some absorptive power, though I have not myself seen curative results from it. The plain tincture of iodine relieves the congested livid condition of the neighbouring skin if painted over it.

Acne.—Sycosis.—Simpson recommended for indolent "menstrual" acne a decolorised iodine paint made by mixing 1 part of compound tincture of iodine with 2 parts liquor ammoniæ, and allowing it to stand for forty-eight hours (Med. Times, i., 1861). The ointment of iodide of mercury is more valuable in acne rosacea, and that of iodide of sulphur in indolent acne and sycosis.

Eczema.—For some late stages of this complaint, especially for dry, red, irritable patches, a 1 per cent. alcoholic solution of iodine is good for occasional use, but may irritate; a better form, suitable for infiltrated chronic places on the hands, contains iodine

$\frac{1}{2}$ a part, iodide $2\frac{1}{2}$ parts, glycerin 120 parts, and this may be painted on once daily, the hands being then covered with lint.

Psoriasis.—In patches of obstinate chronic psoriasis, the ointment of green iodide of mercury, or of iodide of sulphur, is very useful. I can speak especially well of the former, made in the proportion of 1 part to 8 of simple ointment. The effects are often more rapid and decided than those of tar ointment. Occasional alkaline or vapour baths should be used during the treatment (*v. p.* 101).

Pityriasis Capitis.—**Alopecia.**—In branny, scaly conditions of the hairy scalp, and in partial falling off of the hair from debility, painting with iodine tincture acts as a useful local stimulant. It should be combined with other treatment, such as soap frictions.

Pruritus.—In many varieties of this disorder—pruritus pudendi, pruritus senilis—tincture of iodine locally applied often gives much relief.

Tinea Tonsurans.—In simple recent cases of ringworm affecting the body or the scalp a few applications of tincture of iodine or liniment may suffice to cure, but they seldom succeed in an aggravated case. Coster's paste is, however, more powerful, and should be thoroughly painted over the affected part, and allowed to form a crust, which may remain for seven to ten days. One or two such applications will often cure, but to say that they do not cause pain is a mistake. Equal parts of chloral hydrate, iodine and carbolic acid make a good application for occasional use.

THERAPEUTICAL ACTION.—*Internal.*—Iodine and the iodides have a similar action; the former is probably better adapted for slowly modifying the general constitutional state, as, for instance, in tuberculosis; whilst the alkaline iodides, being more quickly passed out of the system, act better where some foreign material needs elimination, *e.g.*, in syphilis, lead poisoning, or rheumatism. The potassium iodide is the one most commonly employed in this country, but the depressing effects of the potassium, especially when it is taken for long periods, have led many to employ the iodides of sodium, ammonium, or strontium in preference to it.

Metallic Poisoning.—Melsens found that every mercurial compound was soluble in an alkaline or neutral solution of iodide

of potassium, and that corrosive sublimate, for instance, if fixed in a muscle, tendon, etc., could be dissolved out of the organic tissue by soaking it in such a solution; also, that even metallic lead was, to some extent, soluble in the same medium, with the formation of a double iodide of lead and potassium (Med.-Chir. Rev., i., 1853). Hence, he argued that in cases of mercurial or lead poisoning, with salivation, tremor, colic, palsy, etc., iodides introduced into the blood could form soluble compounds with metal deposited in the tissues, and enable this to be taken up by the absorbents and passed out by the kidneys, salivary glands, the mucous membranes, and skin. Support has been given to this argument by the fact that an insoluble salt of mercury or lead may be given to animals without evident effect until after the administration of an iodide, when symptoms of poisoning appear. Further, we know, clinically, that sometimes in metallic cachexia, when active symptoms are no longer present, and the poison cannot be detected in the secretions, but if an iodide be given symptoms of acute mercurial or lead poisoning may be developed, and the foreign substances may be found in the urine, etc. *Chronic* conditions of illness, such as palsy or cachexia, may be present when the use of the iodide is commenced, but in the course of a few days *acute* symptoms, such as colic or salivation, may be reproduced until elimination is complete.

The case of M. Faure, recorded by himself, is a good illustration of the value of iodides in cases of lead poisoning. Engaged in white-lead manufacture, he suffered severely from the ordinary symptoms of plumbism, and cured himself with iodide of potassium. He remarks that he could tolerate the drug better when he took it *before*, than *with* food, which he attributed to the "fasting stomach being coated with mucus" (L. Med. Record, 1876).

Dr. H. Thompson has given the details of a case of plumbism, in which iodide of potassium, on three or four occasions, led to relapse of colic at the same time that iodism was developed, and these attacks were always followed by improvement in the paralysed extensor muscles (B. M. J., i., 1871).

I have had some very good results with iodides in cases of plumbism, the best being obtained in conjunction with purgative treatment. The metallic iodide is excreted by the mucous membrane of the alimentary canal, and should be immediately

removed to prevent its reabsorption; hence the necessity for counteracting the constipation which so frequently accompanies this condition. A good formula is, *Magnesii sulphatis*, gr. xv-xxx; *potassii iodidi*, gr. ii-xx; *aquæ chloroformi*, ʒi M. To be taken every four or six hours. Iodide of iron is valuable in later stages.

Syphilis.—It is probable that iodine acts in this disease, much as it does in metallic poisoning, by assisting the elimination of a morbid material. It has been maintained indeed by Dr. Basham and others that its influence is best seen in cases which have been previously treated by mercury; and Dr. Budd and Sir A. Garrod have given instances in which mercurial influence was dormant until excited by the administration of iodides, when profuse salivation occurred and recovery ensued. But there can be no question that the drug has curative powers of its own, independent of mercurial action; they are evidenced especially in the later, or tertiary stages of constitutional syphilis, when either the mucous membranes are affected, as in deep ulceration of the fauces, or the bones are attacked with periostitis or nodes, or the skin is affected with rupial or lupoid eruption, or the meninges are thickened, or gummatous deposits are formed in any of the viscera. In such conditions it usually acts far better than mercury, although this latter drug is preferable in some *inflammations of the eye*, such as iritis; and again, in a certain proportion of undefined syphilitic cases, an iodide and mercury will give better results than either medicine alone.

By causing the absorption of deposits and thickenings in various parts of the body, iodides cure, at the same time, many resulting symptoms, such as those due to pressure on different portions of the nervous system, nocturnal pains, neuralgia, paralysis, dulness of sense or intellect, and convulsive paroxysms. The dose of iodide of potassium is a matter of much importance, and need be limited only by the susceptibility or idiosyncrasy of the patient, and the progress of the disease; it may vary from 1 or 2 gr. up to 60 gr., two or three times daily, and the best results have sometimes been obtained from heroic doses, $\frac{1}{2}$ to 2 oz. daily, when ordinary ones have failed (Hynson).

Elliotson gave doses of 30 to 60 gr., or even more (*Lancet*, i., 1832), and Ricord commonly prescribed the same amount. Sir

A. Cooper, Pollock, and others have given instances of the value of such quantities (B. M. J., and Lancet, 1867-68); and Dr. Buzzard has pointed out the importance of large doses, especially in syphilitic affections of the nervous system (Lancet, i., 1873). *Iodipin* has been given, 40 to 50 grammes daily, or by inunction, without iodism, and with good success (B. M. J., ii., 1900). Iodine, $\frac{1}{4}$ gr., with sol. pot. iod., acid cit., and glycerin, has also acted well.

In **Hereditary Syphilis**, the symptoms in infants are usually "secondary," and mercury is the proper treatment, though if iodides are required, they generally are well borne.

Rheumatism.—Dr. Graves was one of the first to point out the value of iodide of potassium in rheumatism, and it is now well established. I connect its efficient anti-rheumatic action mainly with an eliminant action through the kidneys, and to promote this, recommend it to be largely diluted and combined with bicarbonate of potash in acute cases. To lessen irritation of the stomach, the medicine may be given in the effervescent form. Sometimes if the patient be feeble, and the urine abundant and of low specific gravity, possibly alkaline, the iodide may be combined with hydrochloric acid and quinine, as recommended by Dr. Southey, or given as hydriodic acid. When effusion has occurred into the pericardium or the joints, tincture of iodine or iodides are often of great value. In muscular rheumatism they are useful, especially in those cases where the pains are made worse by warmth, as in bed at night. This is one character of periosteal and syphilitic pain, and possibly some of the good results obtained from potassium iodide in cases of chronic painful joints, sciatica, and lumbago, may be explained by its removing a latent specific or mercurial, or other metallic taint. In cases of chronic rheumatism, small doses of iodide, continued for a long time, often act exceedingly well, but some patients are very sensitive to its physiological action, and need special care to secure its toleration. The use of iodide of potassium is now mostly limited to chronic cases, or to those acute cases where sodium salicylate cannot be tolerated.

In **Chronic Valvular Disease**—arterio-sclerosis, cardiac hypertrophy, and even fatty degeneration, the potassium salt has been strongly recommended by G. Sée and others, who maintain that it is a heart tonic (Year Book, 1891). Laborde has published a case of chronic endocarditis, with mitral reflux, where attacks

of dyspnœa and angina were much relieved by iodide of strontium. In practice where the cardiac action is weak, the *ammonium iodide* may be substituted for the potassium salt, or ammonium carbonate may be given with the iodide of potassium. This seems to act beneficially in two ways: it obviates the depressant effect and increases at the same time the therapeutic activity of the salt. A case with much anginal pain was relieved by *sodium iodide* (Lancet, ii., 1897). The hydrogen compound acts well in such cases.

Gout.—In chronic forms of gout the iodide will often relieve, in 1 or 2 gr. doses thrice daily, well diluted with water or seltzer water. In some cases the tincture of iodine acts better. I have found gouty patients very sensitive to its physiological effects.

Chronic Rheumatoid Arthritis.—In this condition, often considered incurable, I have known the tincture of iodine prove very useful when given in 3 min. doses thrice daily, and applied locally; in certain cases the good effect has been remarkable when given at the same intervals, but in doses of 10 to 20 min.; iodides with arsenic are as valuable.

Gouty Psoriasis.—In this malady the iodide deserves trial. It is possible that some cases may be of syphilitic origin, but in the majority no definite history of syphilis can be obtained. In one which was “inveterate,” and had lasted for twenty years, recovery followed the use of 10 to 30 gr. doses daily (Lancet, i., 1871). It is not meant that this treatment—known by the name of Dr. Haslund—must be limited to cases evidently gouty. He recorded forty cases—five of them acute—cured in from three to eleven weeks, some taking very large doses—30 grammes and more daily; in only one case severe iodism occurred, and two other patients could not tolerate the drug; all were in hospital (B. M. J., i., 1888). Other cases recovered with 3 to 15 grammes daily (*ib.*, i., 1889). I have several times treated obstinate cases in children with 15 to 20 grains of potassium iodide thrice daily, with occasional omissions for several weeks, without harm, but without definite effect.

Ague.—Intermittents.—Potassium iodide has been proved efficacious in intermittent fever (Amer. Journ., 1867; Med. Times, ii., 1872). The tincture of iodine is the “Elixir de Willebrand” used on the Continent in doses of 10 to 15 min., and, it is said, with success (B. M. J., ii., 1874).

Paralysis.—Cases of paralysis which are cured by the use of iodides, are generally dependent on syphilitic inflammation, or on inflammatory deposits or effusions pressing upon nerve trunks or centres. *Progressive Muscular Atrophy* has sometimes yielded to the iodides in a remarkable manner, as instanced in a case of Dr. Murchison's (*Lancet*, ii., 1867). The man, aged twenty-six, had gradual loss of power and wasting, first of the left, then of the right limbs, and then of the respiratory muscles, and apparently progressive paralysis, with moderate pain, and no cerebral symptoms; he got worse under iron, arsenic, and galvanism, but improved markedly under iodide.

Neuralgia.—In cases of syphilitic or rheumatic origin, iodine is useful; and in sciatica the combination of iodide of potassium with vinum colchici is often effective.

Chorea.—Manson affirms that he has cured seventy-two cases of chorea by giving iodide of potassium, and Sir James Bardsley and Gibney have also written in its favour, and considering the close connection with rheumatism evident in so many cases, and the benefit often derived from salicin compounds, there may well be some amenable to iodides, though arsenic or antispasmodics may also be required.

Struma. — Rachitis. — In the different manifestations of these constitutional states, such as enlarged lymphatic glands, tumid abdomen, indolent ulceration, ophthalmia, etc., preparations of iodine, and especially the tincture, are of proved value. But though they lead to disintegration of morbid deposits, they do not appear to assist renovation of tissue, and for permanent results require to be supplemented by good food and hygiene. Hence, also, the combination with iron—iodide of iron—is an excellent form, and the conjoint use of cod-liver oil is desirable. These remedies are invaluable in rachitis especially, and are usually well borne by delicate children when alkaline iodides are not. Simon, indeed, concludes that the latter ought not to be given at all under two years of age (*Med. Record*, 1876), and even the iodide of iron sometimes excites gastric and renal irritation, especially in some delicate children with fair skin, red hair, and enlarged cervical glands, so that it is desirable to commence its use in small doses. In a remarkable case, with upwards of thirty enlarged and suppurating glands, 8 gr. of potassium iodide were

taken thrice daily for eight years, with ultimate complete recovery (Vos, B. M. J., ii., 1897).

Lupus.—I have mentioned the external use of iodine in the treatment of this disease, and there is some evidence in favour of its internal administration. Thus, Mr. Gay records cases of lupus affecting the face—in one man for seven years, in a woman for twenty years—which got well under $\frac{1}{2}$ dr. doses of iodide of potassium (Med. Times, ii., 1871). No history or distinct evidence of syphilis could be obtained, though one cannot but suspect a syphilitic taint in such cases. I have never known iodides cure ordinary lupus, nor is it a common experience.

In **actino-mycosis** iodides in full doses, 15 gr. and upwards, should always be tried—the good effect is often remarkable, almost specific (Lancet, i., 1897, etc.; Acland, Allbutt's System, vol. ii.).

Meningitis.—I have had several cases of meningitis which derived much benefit from iodides, given alone or in combination. One child, aged six years, who had been ill for eight days, and was insensible, with dilated pupils, dysphagia, paralysis of one side, and convulsive twitching, and who had been getting worse under previous treatment, began to improve soon after commencing potassium iodide, given in 5 to 10 gr. doses every six hours, with 5 min. of tincture of belladonna in the intervals. Recovery ultimately ensued, and the boy has now reached adult age. In another case, aged eight years, there were pain, vomiting, delirium, unconsciousness, convulsion, dilated pupils, tetanic stiffness of the neck muscles, grinding of teeth, difficult respiration, slow, weak pulse, and every sign of fully developed meningitis, yet recovery took place under potassium iodide and belladonna. Dr. Leared recorded a case of recovery under 5 gr. doses of iodide of potassium when other remedies had been used without relief. He was satisfied as to the diagnosis of "tubercular meningitis." Other desperate but successful cases are on record (Edin. Med. Journ., 1841; Med. Times, i., 1859; Bulletin de Thérap., 1861, etc.); and M. Golfin (Montpellier) narrates three cases of this malady which recovered from the second or third stage under frictions with an iodide of mercury ointment to the scalp. (Hydrarg. ioid. virid., gr. ij; Potas. iod., gr. iiij; Camphoræ, gr. ij; Cerat. Galeni, gr. xxxij.) In one child, aged four and a half years, the

symptoms showed death to be imminent—the head was drawn back, the face pale, the pupils dilated and immobile, the power of swallowing was lost, partial paralysis, convulsion and profound coma were present; the pulse was scarcely perceptible. About forty hours after commencing the iodo-mercuric inunctions, urine flowed, and the paralysis and convulsion gradually lessened; in the course of four days headache and stupor alone remained, and by the fifteenth day convalescence had set in (*Gaz. Méd. de Montpel.*, 1847). Niemeyer speaks favourably of iodic frictions in basilar meningitis.

Trousseau and many physicians of experience deny that the tuberculous form is curable under any circumstances, and certainly a large majority of such cases end fatally. Dr. Wilks “has seldom seen any good results” (*Med. Times*, ii., 1868; *Pract.*, i., 1893).

Phthisis.—In the more acute form of phthisis, when the patient suffers from loss of flesh, quick pulse, high temperature, pain, cough, dyspnœa and nocturnal sweatings, the tincture, given every four hours, and inhaled, as well as applied locally over the chest, offers a chance of arresting or ameliorating the disease, as I know from some cases under my own care. In the absence of acute symptoms I have also seen benefit from iodine and iodides, but have sometimes noticed hæmoptysis following their use, and therefore recommend caution in cases disposed to hæmorrhage.

Earlier observers—Chevallier, Elliotson, Bardsley, and others—thought iodine really curative in consumption. It can certainly lessen pulmonary induration, and modify the irritative conditions of the bronchial mucous membrane and the character of the expectoration: in fact, I have seen most symptoms improve under its use, but this must be supplemented by good hygiene and generous living. Dr. Cotton’s experience at Brompton Hospital was not so favourable: weight was seldom gained under potassium iodide, but was generally diminished; dyspepsia was sometimes induced; usually, no definite effect could be traced (*Med. Times*, ii., 1859). Dr. Julius Pollock, on the other hand, found the remedy very serviceable, and his patients gained weight. I have noted most benefit in cases of *chronic* phthisis, and especially when a syphilitic taint existed. Sir Walter Foster

suggests that it acts by stimulation of the pancreas, thus promoting assimilation of fatty food, and Claude Bernard proved that it was eliminated by that gland.

Iodine inhalations in phthisis have proved of great value in my experience, exerting a disinfectant, and to some extent an absorbent, action. Continuous inhalation of antiseptic vapour from an ori-nasal inhaler is often useful, and a solution of about 3 gr. iodine in ether 2 dr. with the same of carbolic acid, and half the amount of thymol or creosote made up to an ounce with spirit, may be dropped on the inhaler—10 min. or upwards at a time (B. M. J., i., 1881). Formalin (which is a 40 per cent. solution of formic aldehyde) has to some extent now superseded this.

Bronchitis.—In the subacute and chronic stages, alkaline iodides relieve by an alterative action on the bronchial mucous membrane, thinning and ultimately diminishing the muco-purulent tough secretion, and so rendering expectoration easier. They may sometimes with advantage be combined with antispasmodics. Potassium iodide should be given for this purpose in doses of 2 or 3 gr.; but in weakly subjects, the iodide of ammonium, in doses of from 2 to 5 gr. every four hours, may act better. When there is an increase of temperature, aconite also should be given in doses of from 1 to 3 or 5 min. every two to four hours. If an expectorant be required, tartar emetic should be chosen; the dose should be small and frequent, and care should be taken to avoid emesis or undue depression.

Pneumonia.—Dr. L. Gualdi of Rome recorded thirty-nine cases of pneumonia, which he treated with 40 gr. doses of potassium iodide every two hours with excellent results. An ice-bag was applied over the seat of the inflammation, and his mortality was only 6 per cent.—it is probable that most of the cases were catarrhal (Lancet, ii., 1884). This method of treatment is heroic, and only suited—if at all—for the early stages; after hepatisation has set in, the drug is, in my opinion, not only useless but injurious.

Asthma.—I have known iodide of potassium relieve many asthmatic patients, and Horace Green (1860) found it to be the main ingredient in a secret and successful remedy for asthma. Trousseau and Jaccoud speak of its value, and M. Sée has recorded valuable observations upon twenty-four cases watched for a long

time. Four of these were children, four old people, the others adults; the daily dose varied from 22 to 45 gr., being reduced as improvement progressed: if given some hours before the usual attack this was often prevented; if given during it, respiration was rendered free in one to two hours. Chronic asthma with emphysema was also benefited by the remedy; inhalations of iodide of ethyl, 6 to 10 drops several times daily, and the occasional use of opium or chloral in these latter cases, were with advantage conjoined with the treatment (Med. Record, 1878). The late Dr. Hyde Salter observed benefit from iodide of potassium in full doses—15 to 30 gr.—every two to four hours, in very diverse cases of asthma. I think that such attacks as are connected with catarrh, and are relieved by free secretion, and in which the nerve-symptoms are reflex rather than primary, show the best results from this remedy. I have known it efficacious in asthma connected with amenorrhœa and uterine congestion, and also in the asthma of rheumatic and gouty subjects. In an interesting case in a very rheumatic patient, the asthmatic attack was relieved by 4 gr. doses of iodide, but severe pain in the region of the kidney followed, with secretion of scanty acid urine; this occurred more than once, and was only relieved by producing free excretion of alkaline urine by appropriate remedies (B. M. J., i., 1875). In this case, the drug was supposed to cause renal congestion by increasing the absorption of waste nitrogenous material, *i.e.*, the amount to be eliminated. I have known iodine itself produce renal congestion in some individuals; hydriodic acid will sometimes act better (Bost. Journ., 1880; N. Y. Rec., 1879 and 1893, etc.). Dr. C. J. B. Williams has seen a large number of asthmatic cases relieved by iodide and by carbonate of potassium, with stramonium (Med. Times, i., 1872), but most of M. Sée's cases were relieved by the iodide alone.

Catarrh.—Ammonium iodide, in 1 gr. doses every two to four hours, is a good remedy in ordinary acute nasal catarrh hydriodic acid is also useful, and is suitable for influenza.

Hay Asthma.—In this distressing malady, iodide of ammonium, combined with arsenic, will often give a better result than either remedy alone. The vapour of iodine, or of a mixture of carbolic acid and iodine, should be inhaled by the nostrils, as recommended by Melville (Lancet, ii., 1864).

Diphtheria.—The tincture of iodine and the iodides have been used with benefit in the early stages of this disorder, either with or without the perchloride of mercury, but the introduction of the antitoxin treatment has in a measure displaced this method.

Albuminuria.—The prolonged administration of potassium iodide in chronic Bright's disease is said to have retarded fibroid changes in the kidney, and induced general improvement in nutrition (Bartholow). Dr. Créqui (Brussels) recommends it for the second or parenchymatous stage. Using commonly 6 gr. or more daily, he has sometimes given as much as 6 dr. in the day, with bismuth or opium to control irritative effects. He presumes the iodide acts by limiting morbid secretion in the renal tubules (Lancet, i., 1871). In subacute cases, with dropsy, I have frequently used this remedy in doses of 3 to 4 gr., and have seen apparent advantage from it. I think it hastens absorption of inflammatory products, but from what has been already stated as to the possibility of its causing renal congestion, it must be considered unsuitable in acute nephritis, unless in fractional doses.

Ascites.—Anasarca.—Not only in renal dropsy, but in that dependent on hepatic disease, and also in general anasarca due to abnormal conditions of the blood, potassium iodide or iron iodide is useful. In all these cases the salt is of value, possibly on account of the diuresis induced by it. Frictions with iodised liniment should be combined with the internal treatment.

Aneurism.—In those cases of thoracic and abdominal aneurism, in which surgical treatment is impossible or highly dangerous, the clinical results obtained by potassium iodide should not be ignored. Nélaton recorded marked relief to the signs and symptoms of an innominate aneurism under the use of this remedy, which he gave empirically at the request of the patient, and Bouillaud, following up this clue, obtained good results in aneurisms of the carotid and thoracic vessels (Med. Times, i., 1859).

Chuckerbutty, in Calcutta, published an account of three cases which were relieved; in one of these the aneurism was already projecting through the sternum when the drug was commenced; and Sir W. Roberts and Mr. Windsor recorded some equally striking results about the same time (B. M. J., ii., 1862; i., 1863).

It is, however, to Dr. G. W. Balfour that we are most indebted for drawing professional attention to this subject (Edin. Med.

Journ., 1868-69, and Lectures on Heart Disease, 1898). In his first paper he summarises fifteen cases, all of which, save one, were relieved, and in twelve the external tumour was actually lessened and the sac partly consolidated. In one of his earliest patients the bulging, which was evident between the second and third ribs, disappeared after a few weeks' treatment with 30 gr. doses thrice daily, and this dose was continued for nine months "without any unpleasant symptoms," but with complete subsidence of aneurismal suffering. The same man had not improved under previous doses of 20 gr., and Dr. Balfour points out the importance of pressing the drug to saturation before considering it inert. It is very quickly eliminated—large doses within two or three days—and many of his patients took 20 to 30 gr. several times daily. In a few, coryza and headache were quickly produced, and 5 gr. only were tolerated, but, as a rule, no worse symptoms were caused by large than by small doses. Additional evidence in favour of this treatment has been furnished by Sir W. Roberts, Dr. Shapter, and others (*Med. Times*, 1874; *B. M. J.*, 1873-74); and Dr. Philipson and Dr. Snow have reported cure of abdominal aneurisms (*B. M. J.*, i., 1878; i., 1891).

Dr. Suckling has contributed an additional series of twenty cases treated by potassium iodide, in doses of 10 gr. increasing to 60, combined with Tufnell's diet; of these twelve were benefited, but he notes that in several the pulse rate increased, and the drug then disagreed. Referring to these cases, Dr. G. W. Balfour again points out the necessity of regulating the dose by the effect on the circulation: after some days in bed the patient's normal pulse should be ascertained, and doses of 10 gr. commenced, and then later increased to 15 gr. if the pulse rate remain unaltered, the object being to lower blood-pressure within certain limits. Although in his early writings on the subjects already quoted, Dr. Balfour was inclined to attribute to a sedative action on the nervous system the good effects of the drug, he has, for some time past, traced them rather to lowering of blood-pressure consequent on dilatation of arterioles, and some depression of heart-action (*cf.* p. 75); following this, more resisting power develops in the sac, the coats of which tend to hypertrophy and so to cure, whilst if the nutrition be unduly lowered by starvation diet, or by excessive doses of iodide removing albuminates from the system, the hyper-

trophy is hindered ; if the pulse quickens under iodide, he concludes that tension is unduly lowered, and the dose too large (B. M. J., i., 1887 ; i., 1891). (In Dr. Haslund's cases of psoriasis treated by very large doses, the pulse usually went up to 100-110 in ten to fourteen days.) G. Sée states that the *sodium iodide* will not produce these good effects in aneurism (Lancet, ii., 1889).

It seems to me no argument against such cases to say, with Dr. Bristowe, that any remedy which coagulates the blood in an aneurismal sac must tend to coagulate it elsewhere, and is therefore inadmissible ; or to note with Mr. Holmes that aneurism may sometimes develop in patients already under the influence of iodide (Med. Times, i., 1872). This is only saying that the remedy is not infallible, and that its mode of action, whether on the blood, blood-pressure, nervous system, or walls of the sac, is not yet clear. For one point, the *primary* physiological action of iodine and iodides is to raise the blood-pressure (v. p. 75 ; cf. Gairdner, Allbutt's System, v., vi.). I have myself seen remarkable advantage from their use, and suggest, in addition to the above explanations, a possible antisypilitic effect—for the frequent connection of syphilis and aneurism is sufficiently proved.

Bronchocele.—In simple soft goitre, in which malady, indeed, the reputation of iodine was first acquired, I consider it almost a specific. In recent cases, 1 to 5 min. doses of the tincture produce the best results, for if unduly large quantities be given, the swelling becomes hard, tender, and painful. In more chronic cases already indurated, large doses— $\frac{1}{4}$ to 1 gr. of iodine—may be given in conjunction with its external use : some tonic or bitter preparation, *e.g.*, of cinchona or orange peel, should be added to prevent derangement of the stomach. Mr. Bryant has known goitres rapidly disappear under the influence of an iodised atmosphere obtained by simply placing iodine in a perforated box in the patient's room ; he recommends also the local use of an ointment of iodide of ammonium (Practical Surgery, 3rd ed.).

In **Exophthalmic Goitre** I have also seen a limited amount of success from the internal use of iodine tincture, the palpitation being frequently relieved by small doses. The case of a girl of sixteen recovering in four months under potassium iodide, in 10 gr. doses (with iron) and iodine ointment locally, is recorded (B. M. J., Ep. ii., 1892). Sée however argues that the salt

must be injurious in this disease, because dilatation of arterioles is already too great (Lancet, ii., 1889). On the other hand, Dr. Reynolds finds it an important element in satisfactory treatment, combined with iron and bromide. In cases with large goitre and marked exophthalmos, 10 to 15 gr. of iodide thrice daily could be taken, and "seemed most effective in reducing palpitation of the heart and frequency of the pulse" (Lancet, i., 1890).

Chronic Inflammatory Indurations.—In simple chronic enlargement of organs, such as the liver, the spleen, the mammary gland, or the testes, iodine is often of more service than any other medicine. The cause may be syphilis, struma, or malaria, inflammation from cold, etc., and yet the same remedy be applicable. I generally recommend 1 to 5 min. of the tincture thrice daily for a long period, though sometimes iodides are better borne. Painting with iodine or compresses should be used at the same time. Iodides have been found valuable in relieving the symptoms of gall stone, especially when they have been continuous rather than in paroxysmal attacks (B. M. J., Ep. ii., 1896).

Uterine Fibroma.—Fibroid growths or indurations, especially those originating in the cervix, *i.e.*, in the more glandular and secretory part of the uterus, often improve under the use of iodine or iodides. Dr. Ashwell long since described them as "melting down" under this treatment (Guy's Reports, vol. i.), and mineral waters, of deserved repute in such cases, owe their efficacy to a combination of iodides and bromides. Potassium iodide has been very useful in metrorrhagia, but it was apparently from a syphilitic growth (B. M. J., i., 1898). The injection of iodine—Durante's method—a solution of 1 to 5 per cent. with potassium iodide, daily injected into muscular or glandular tissue, has given good results in diphtheroid lesions of the uterus and vagina (B. M. J., Ep. i., 1896).

In **Passive Uterine Congestion** tincture of iodine is often useful; and Dr. J. B. Schmidt has written to recommend minim doses for chlorotic subjects suffering from headaches, frequent menstruation and diarrhœa (Med.-Chir. Trans., i., 1871).

Amenorrhœa.—Sterility.—When these conditions depend on functional causes, such as local congestion or general weakness, iodine and the iodides are useful. I have often proved them so in the former condition, and sometimes in sterility they exert a

stimulating effect on the uterus, possibly because of their elimination by the mucous membrane.

Vomiting of Pregnancy, etc.—I have known 1 to 5 min. doses of the tincture arrest the capricious vomiting, also the pyrosis and heartburn of pregnancy, possibly by a stimulant effect on the gastric membrane. Its local application to the cervix, conjoined with its internal administration, often acts advantageously. Dr. Eulenburg recommends 10 min. doses as serviceable, but I prefer the smaller ones repeated every two or three hours. In other obstinate cases of vomiting the same treatment is often of service, especially in the vomiting of phthisis (Roques, *L'Union Méd.*, 1889).

Atonic and Dysenteric Diarrhœa, etc.—I have obtained benefit from similar doses in atonic diarrhœa, and in the form which occurs during phthisis. They have been recommended in cases of passive hæmorrhage and serous flow into the intestine, dependent on "paralysis of the ganglionic centres" (Schmidt, *Med.-Chir. Rev.*, i., 1871); also in later stages of typhoid fever. Iodised enemata have been used in dysentery to relieve tenesmus (*Med. Times*, i., 1857); 1 to 5 min. doses of the tincture, given every four hours with cinchona, will often cure the tormina and the tenesmus of dysenteric diarrhœa. Iodine $\frac{1}{4}$ gr. in sol. pot. iod. has proved an effective remedy for tapeworms; these have been expelled dead under its use (*Lancet*, i., 1895).

PREPARATIONS AND DOSE.—*Tinctura iodi* contains iodine $\frac{1}{2}$ oz., iodide of potassium $\frac{1}{2}$ oz., distilled water $\frac{1}{2}$ fl. oz., alcohol (90 per cent.) a sufficient quantity to produce one pint: dose, 2 to 5 min. *Liquor iodi fortis* contains 11 $\frac{2}{3}$ per cent. of free iodine, with 7 per cent. of potassium iodide, it replaces lin. iodi (B. P., 1885). *Unguentum iodi* contains 4 per cent. of potassium iodide, and 4 per cent. of added iodine. *Potassii iodidum*, *sodii iodidum*: dose, from 5 to 20 gr. and upwards: average dose, 3 to 5 gr. The following are not official—*Strontii iodidum*: dose, 3 to 5 gr. and upwards. *Ammonii iodidum*: dose 2 to 10 gr. *Hydrogenii iodidum* (hydriodic acid), *Syrupus* (B. P. C.): dose, 20 to 40 min. *Gardner's Syrup*: dose, $\mathfrak{z}\text{i} = 5$ gr. of potassic iodide (before meals). *Æthyl iodidum* (hydriodic ether), for inhalation or paint. *Iodates*:—*Iodipin* (oil compound), (v. p. 71). *Iodalbacid* (albumin compound): dose, 15 gr. *Amylum iodatum* (starch compound): dose, $\frac{1}{2}$ to 4 dr. Iodised milk (Selavo) is used in Italy and contains an albumin compound. It is prepared by dissolving iodine in fresh "separated" milk, kept aseptic by a little chloroform. *Iodopyrin*: dose, 5 to 20 gr. (B. M. J., i., 1892). *Iodothyryn* (thyroid compound), 0.3 per cent. iodine: dose, 5 gr. and upwards. *Tinct. iodi decolorata*. *Vin Nourry*, $\mathfrak{z}\text{jss} = \frac{3}{4}$ gr. iodine in Malaga wine.

ADMINISTRATION.—Opinions are still divided as to the best time for giving iodides with relation to food.

Dr. Parkes and others recommend them to be taken before meals, in order to prevent decomposition by acids, and to secure dilution with mucus: this is specially desirable with hydriodic acid. Some give them at bedtime with effervescence; and, again, others find them better borne by a full stomach. All agree that they should be freely diluted, and not taken when there is much starchy food in the stomach, and if there are no febrile or acute gastric symptoms, a bitter infusion or tincture is a good vehicle; in other cases milk is very suitable. Large doses sometimes produce less iodism than small ones (Althaus).

ADULTERATION.—The iodides sometimes contain iodates of the respective alkalies, and not infrequently an excess of water, and after keeping, free iodine is developed to some extent.

IODOFORMUM—IODOFORM ($\text{CHI}_3 = 394$).

CHARACTERS.—The ter-iodide of formyl crystallises in small, pearly, yellow, crystalline scales of unpleasant sweetish taste and penetrating, saffron-like odour. It is nearly insoluble in cold water, but soluble to the extent of 10 per cent. in boiling spirit, and of 20 per cent. in cold ether, and entirely soluble in warm ether. It is also soluble in chloroform, bisulphide of carbon, and oils: the solutions should be neutral to litmus paper. It is partially volatilised by heat, and contains 96·7 per cent. by weight of iodine. A so-called “absolute iodoform” is prepared by electrolysis—it is a quite pure, soft, scaly powder of citron-yellow colour and less strong odour: “precipitated” iodoform is pale yellow and impalpable—not crystalline. The “aromatic” is scented with coumarin.

ABSORPTION AND ELIMINATION.—Högyes states that if the drug be introduced into the stomach in the solid form the first step is its solution in any fatty matter, such as the chyle of the intestine. The oily solution next gives up its iodine to any albuminous substance or alkali present; these compounds pass speedily into the blood, while a few minute coagula and oil globules are left behind. From raw surfaces also it is absorbed, and if in large quantity may give rise to toxic symptoms: there seems to be some idiosyncrasy in this respect. The iodine, or the greater part of it, is gradually eliminated from the system in

combination with potassium or sodium and by the same channels as when it is administered in the form of tincture, or iodide, namely, by the urine, saliva, tears, milk, sweat, and the secretions of mucous membranes (Archiv f. exp. Pathol. u. Pharm., Bd. x.). It would seem that the greater quantity passes out by the kidney ; there is, however, sufficient iodine set free again in the perspiration to confer upon that secretion an unpleasant odour (Binz). Dr. G. Rummo finds that the drug is eliminated mainly as sodium iodate in the urine, but a small quantity passes off unchanged by the lungs (Arch. de Physiol., 1883).

PHYSIOLOGICAL ACTION.—*External.*—Under conditions which set free its iodine, *e.g.*, when brought in contact with suppurating offensive discharges, it acts as an antiseptic and deodoriser of considerable power. It also destroys leucocytes, and Binz finds that it prevents their migration when applied to the frog's mesentery (Virchow's Archiv, 1889). It has been said not to cause local irritation, but I have known it do so when applied to abraded surfaces, especially inflamed ulcers. Bullous dermatitis has occurred on the hands after handling the drug (Lancet, i., 1898 ; B. M. J., i., 1899), as it has apparently from iodine paint in an albuminuric subject (Lancet, ii., 1895). It has some power as a local anæsthetic ; thus a suppository containing it, when introduced into the rectum, may so diminish sensibility that defæcation may occur unconsciously. Hëyn and Roosing, of Copenhagen, point out that admixture of iodoform with cultures of bacteria does not prevent the growth of the latter. They admit the usefulness of iodoform in surgery, but deny that its power is due to any germicidal properties, and so recommend the use of corrosive sublimate at the same time (Fortschr. der Med., 1887). This paper was received with some scepticism, as every surgeon could quote cases of rapid healing and cleanly wounds under the use of iodoform alone ; Dr. Friedländer, however, defended the genuine character of the research, and Dr. Potess pointed out their probable error in supposing that iodoform mixed with cultures is the same as iodoform in contact with the tissues of the body ; in the latter case free iodine is liberated. It has more lately been shown that if bacteria are taken from a wound which has been dressed with iodoform their vitality is little if at all reduced. The undoubtedly good effect of iodoform manifested by the healing of wounds under its use has, therefore,

been ascribed to a beneficial action on the tissues themselves, both directly, and indirectly as a protective agent.

PHYSIOLOGICAL ACTION.—*Internal.*—Although chemically analogous to chloroform, iodoform is not nearly such a powerful anæsthetic,—probably because of its insolubility and consequent slow absorption. When it is given in small doses iodine is liberated in the body, and to this is due its alterative action.

Circulatory System.—It depresses the circulation when applied to the frog's heart, having a paralysing effect like that of chloral on the cardiac ganglia. In animals poisoned by iodoform, extravasations of blood have been found *post mortem* (Med. Record, 1879), a condition analogous to the hæmorrhages occasionally produced by the administration of iodine or iodides. Toxic doses first show a stimulant effect in man by flushings, due to the dilating effect of the drug on the arterioles, and by palpitation of the heart; subsequently this organ becomes weak, and both it and the respiration are paralysed, much in the same way as in batrachia (Schmidt's Jahrb., cxv., and Med. Record, 1879).

Nervous System.—Maître compares the effects of iodoform to those of alcohol. After moderate doses— $\frac{1}{2}$ to 1 gramme—the dog experimented upon lay at rest, or if made to rise, staggered and fell; by the next day it had recovered. After 3 or 4 grammes, intense excitement set in, with quickened circulation, convulsive contractions of the limbs, and opisthotonos like that produced by strychnine. Its local anæsthetic effects have been already noted, and it has considerable value in relieving neuralgia (Bouchardat, Annuaire, 1857). Franchino produced a slight anæsthesia in dogs, rabbits, and birds, by making them breathe 2 grammes of iodoform, volatilised by means of bellows in a closed chamber: here the two stages of the drug's action were observed—first, contraction of the muscles, then relaxation and anæsthesia for five or ten minutes, followed by gradual recovery. Binz attributes the symptoms in part to the carbonic acid confined in the chamber (Archiv f. exp. Pathol., viii., 1877). Dr. McKendrick, comparing the drug with chloral, found that 10 gr. dissolved in 1 dr. of alcohol, and injected under the skin of a rabbit, produced profound sleep for four hours, whilst 12 gr. destroyed life; Binz failed to verify this result, and attributed the sleep mainly

to the alcohol. In his experiments, 2 grammes dissolved in oil and administered subcutaneously to dogs and cats, produced moderate sleep in the course of an hour, and 3 grammes impaired the functions of the brain and spinal cord without being necessarily fatal. He concludes that moderate doses exert some narcotic effect, especially on dogs and cats, and that toxic doses kill by general paresis, with lowering of temperature (*Edin. Med. Journ.*, 1874). Högyes, making observations in order to try and reconcile the discrepancies in the above statements, found that large doses caused marked drowsiness in dogs and cats, but not in rabbits, and that during somnolence reflex irritability was not much impaired. Toxic doses cause death by gradual paresis of circulation and respiration (*Med. Record*, 1879). In man, its toxic effects are most often seen in cases where a large amount of the powdered drug is placed in contact with absorbing surfaces, from which there is not very free drainage, as in a sinus or a nearly closed abscess cavity. The stages of the poisoning correspond to the two stages seen in animals, there being first excitement of both circulatory and nervous systems, and secondly, paresis. The former is evidenced by the palpitating heart, and the flushed face, the latter by subsequent heart-failure; in the nervous system there is first sleeplessness, headache, loss of memory, irritability, and in severe and exceptional cases attacks of violent mania, hallucinations or melancholia may supervene; this state is succeeded by one of narcosis. Many such cases have been recorded, amongst others four typical ones at University College Hospital by Mr. Stanley Boyd (*B. M. J.*, i., 1882). Dr. Thomann has described a diffuse erythema, as well as circumscribed red spots (*Lancet*, i., 1882).

Schele, Kocher, and others have also published cases of poisoning, and even death, from similar causes (*cf.* *Lancet*, i., 1895, and *B. M. J.*, i., 1897). In Dr. Black's case, delusions of exalted character are mentioned (*B. M. J.*, i., 1885).

Amblyopia has been traced to its use, but has disappeared on its omission (*Lancet*, i., 1897).

Digestive System.—It is remarkable that iodoform, though containing so large a percentage of iodine, does not usually irritate the gastric mucous membrane, unless given in very large doses: many patients, however, object to the disagreeable taste produced.

V. Morax finds that on giving it to dogs decomposition in the intestine is prevented to a very great extent, none of the products of such change being found in the urine (*Zeit. f. physiol. Chem.*, x.).

Pathological Changes.—After death from iodoform poisoning, fatty degeneration has been found in the liver, kidneys, heart, and voluntary muscles. Binz attributes this to the setting free of iodine in the body.

SYNERGISTS AND ANTAGONISTS.—*V. Iodine.*

Potassium bromide has been used as an antidote (*Therap. Gaz.*, 1889), and Behring states that the bicarbonate, in hourly doses of 10 gr., will lessen the toxic effects previously described (*Wien. Med. Blätt.*, 1884).

INCOMPATIBLES.—Several substances, such as calomel and nitrate of silver, decompose iodoform on exposure to light, and especially with heat; but as the decomposition practically results only in liberation of iodine, it does not much, if at all, affect the therapeutical result.

THERAPEUTICAL ACTION.—*External.*—**Ulceration.**—The antiseptic and deodorant qualities of iodoform render it useful in the prevention of decomposition, as in surgical wounds, also in cleansing and rendering inoffensive wounds and ulcerations of all kinds, especially in military surgery, and where carbolic acid cannot be used.

When the skin is broken and there is purulent discharge as in severe burns and chilblains, iodoform, or its ointment, will disinfect the pus, promote healing, and, in virtue of its anæsthetic power, relieve pain. It favours cicatrisation in a remarkable degree, but should not be used while the ulcers are acutely inflamed. This stage being passed, the surface should be carefully cleansed and dried, and then either the finely powdered crystals or a solution in ether (1 part to 8 or 10) should be applied and covered with lint; the ether evaporates, leaving a thin film of iodoform (*Med. Record*, 1878). A dry dressing of iodoform wool is, in many cases—in burns, for instance—more serviceable. From observations in eczematous cases, it is found to be of most use during the puriform stage, and ceases to be suitable when the discharge becomes watery (*B. M. J.*, i., 1881). In late stages of ulceration, it sometimes hinders the formation of epi-

thelium (Practitioner, 1889). Iodoform ointment is useful in pustular eczema capitis, but Dr. Mackey has seen serious symptoms under its use in children (half the B. P. strength), and prefers loretin or aristol.

In ulceration about the mouth and face, even when carcinomatous and unsuitable for operation, powdering the sore with iodoform greatly relieves the patient, lessening pain, and removing the offensive stench. There is some evidence that the crystalline form relieves the pain of such cases better than the "pulverised" (B. M. J., ii., 1889).

In syphilitic ulceration and gummata of the tongue and throat, with ragged, thickened epithelium, deep fissures and severe pain, iodoform is useful applied locally to the part; also in cutaneous tuberculosis.

Chancre, Bubo.—M. Lailier, in a large experience at the Hôpital Loureine, found iodoform a most useful dressing for all forms of venereal ulceration (Lancet, ii., 1878). The late Mr. Berkeley Hill adopted it as an almost invariable treatment of "specific sores," and many other observers have abundantly confirmed the statement of its value (Med. Times, i., 1875; Practitioner, i., 1879; B. M. J., i., 1878). If secretion is abundant *the sore should be cleansed*, and dressed twice daily with the finely powdered crystals or iodoform ointment. Smarting may be caused at first, but this and the pain of the disorder soon subside, and healing often takes place in a week or ten days. The unpleasant odour of iodoform is, however, a drawback to its use, and its results are not always so satisfactory as described above, so that many substitutes have been introduced (*v. p.* 121). Dr. Thomann has used a solution of iodoform in almond oil or glycerin (3 parts in 10) for hypodermic injection in cases of syphilis. No local suppuration was produced, and in early cases the symptoms subsided quickly. The dose given was 0·3 at the beginning, and later, 0·7 gramme.

Otorrhœa.—When this arises from aural polypus, or from granulations on the membrana tympani, or from caries affecting the meatus, insufflations of powdered iodoform are most useful in keeping the discharge sweet, and promoting cicatrisation.

Ozœna.—In this obstinate disorder, and in various cases of post-nasal ulceration and discharge, the local use of iodoform is

much recommended. It is best applied as snuff, and one great relief it gives is the lessening of the stench which often renders the lives of these patients intolerable. It may also be applied to the nose in the form of a bougie containing $\frac{1}{6}$ to $\frac{1}{2}$ gr. made up with gelatin and glycerin. Dr. Woakes found an ethereal solution very painful, and obtained good results with pledgets of iodoform wool (B. M. J., i., 1878).

Lupus.—Iodoform deserves a careful trial in this form of ulceration also: an iodoform collodion is much used as an application in Vienna. It may be preceded by the thorough use of nitrate of silver.

Fissure of Anus.—**Hæmorrhoids.**—The ointment or suppository of iodoform relieves the pain of defæcation connected with these maladies.

Dyspareunia.—In a case of hyperæsthesia of the vulva without local lesion, powdering with iodoform rendered the parts insensitive to pain (Tanner). A tampon of iodoform was followed by good results in another case.

Tuberculous Glands.—**Bronchocele.**—The application of iodoform ointment to the skin over the enlarged organs has often the same results as painting with iodine (*v.* Iodine). Dr. E. Marchand finds that iodoform delays the formation of giant cells (Virchow's Archiv, v., 93). An iodised collar of iodoform wool is a good method of applying the medicament in cases of goitre. Mosetig von Moorhof introduced a method of injecting iodoform emulsion into soft thyroid tumours with antiseptic precautions, and a further series of fifteen cases, said to have been successful, are reported (Lancet, ii., 1891). This method has since been largely practised, more abroad than in this country, and with much success. The formula recently given is Iodoform gr. xv, Ol. Oliv., Ætheris aa ʒ i $\frac{3}{4}$ —the canula being introduced about 1 inch into the goitre, avoiding veins, fourteen or fifteen drops are injected; this causes a moderate amount of pain and swelling, but may be repeated every two to five days (Abstract, Practitioner, 1896; Lancet, ii., 1899; *v.* p. 85).

Orchitis.—**Prostatitis.**—**Mammary Growths.**—Similarly in these affections iodoform acts like iodine when applied locally.

Pleuritis.—**Phthisis.**—In the flying chest-pains of these affections, iodoform collodion (1 part in 15 to 20) often acts better

than iodine paint, and is said to exert the further effect of lowering the temperature of the body (B. M. J., i., 1879).

Erysipelas.—Dr. C. C. Burman used iodoform-collodion as a paint in erysipelas, with satisfactory results (Pract., i., 1884).

Cold Abscess.—Professor Verneuil finds that the injection of an ethereal solution of iodoform (1 in 20) into the cavities of cold abscesses promotes healthy action (Revue de Thérap., 1884). This method has since been much used and commended, and Mr. Mayo Robson has reported many satisfactory cases (B. M. J., i., 1891). V. Moorhof prefers an emulsion (*ib.*, i., 1890), for which a good formula is given by Mr. A. E. Barker: Iodoform 10 parts, sufficient spirit to damp in a clean mortar; triturate with water 20 parts and glycerin 70 parts. It is also good in tubercular joint disease (Lancet, i., 1892; *v.* Bronchocele).

Onychia.—The duration of this very painful and obstinate form of suppuration may be much shortened by iodoform ointment, of strength 1 dr. to 1 oz. (Med. Times, ii., 1872; Med. Record, 1878). I have used it frequently, with excellent results.

THERAPEUTICAL ACTION.—*Internal.*—**Stomach Disorders.**—It may be given in the form of pill made up with sugar of milk and glycerin of tragacanth, and is found useful in cases of dyspepsia, associated with fermentative changes in the stomach.

Phthisis.—Iodoform has been given internally and in the form of spray in this disease, but with doubtful results. As an inhalation, a solution may be used containing iodoform 20 gr., oil of eucalyptus 20 min., rectified spirit $\frac{1}{2}$ oz., and ether $\frac{1}{2}$ oz., dropped into a respirator made of cotton-wool and covered with horse-hair. Dr. Dreschfeld, who recommended this, reported gain in weight, etc., in some cases of phthisis treated by iodoform, but he often combined with it croton chloral and creosote (B. M. J., ii., 1883).

Dr. Ransome records slight, or doubtful improvement of phthisis under iodoform (B. M. J., i., 1884). Dr. Shingleton Smith speaks more positively and says that in some, but not in all, cases the number of bacilli was lessened (B. M. J., ii., 1884). Beetz obtained excellent results from the insufflation of powdered iodoform in cases of laryngeal phthisis (Berlin klin. Woch., 1882). Gussenbauer maintains, but incorrectly, that the drug is specific in arresting the tubercular process; while Dr. Hunter Mackenzie and others conclude that very little dependence can be placed

upon it (B. M. J., ii., 1884). Moreover, it is not always well borne, and I have known patients refuse to continue it on account of persistent nauseous taste which impaired appetite.

In caseous broncho-pneumonia, however, Semmola speaks well of it (Lancet, ii., 1882); and from Liège are reports of its efficacy in hæmoptysis—2 gr. per diem in 3 doses acted in two or three days, and more quickly than ergotin; tannin was sometimes combined (Progrès Méd., 1888). Tubercular meningitis and tubercular diarrhœa have improved under it (*ib.*). Dr. Brower after applying by inunction to the shaved scalp, twice daily, 1 part of iodoform in 5 of vaseline, has also seen much improvement in the former complaint (Pract., 1888). From hypodermic injections, night and morning, of an oil emulsion of iodoform, Gavoy reports very marked benefit in cases of tubercular bronchitis (Gaz. Méd. de Paris, Feb., 1891). Picot combined the same with guaiacol in phthisis (Year Book, 1892).

Diabetes.—Professor Moleschott recorded five cases in which 40 to 50 centigrammes given daily produced favourable results (Lancet, i., 1882). Bozzolo has confirmed this (L. M. Record, 1884), but I am not aware of other corroboration.

Gout.—If Testa's observations represent the average results, the remedy ought to prove a valuable one, for he found it (1) augment organic changes, oxidation and excretion of urea; (2) oxaluria was lessened, as also was the excretion of uric acid, but this because of its increased conversion into urea; (3) the uric acid in the blood was diminished. He reports clinically that seven cases of gout taking from $1\frac{1}{2}$ to 3 gr. doses were relieved as to pain, frequency of attack, etc., but considers the drug contra-indicated by the presence of renal disease (Record, 1885). It has been used for neuralgia (*v.* p. 114).

Worms.—The use of iodoform as an anthelmintic was first advocated by Professor Sim, who stated that 1 gr. doses killed both tæniæ and ascarides (Med. and Surg. Reporter, 1881). This was supported by Szydlowski, who had three successful cases (Vratsch, 1882), and by Makeroff, who recorded one (*ib.*, 1883). Nikolsky, however, found it of no use (Russkaia Med., 1883).

PREPARATIONS AND DOSE.—*Iodoformum*: dose, $\frac{1}{2}$ to 3 gr. in pill, with sugar of milk, tragacanth and glycerin, or pastilles containing 2 gr. in each. Capsules containing a solution in ether, known as "perles de

Clertan" are a good form. Bonner gives it in honey, especially to children. The official preparations are *suppositoria iodoformi*, 3 gr. in each, and *unguentum iodoformi*, 1 part in 10. The *collodium iodoformi*, 1 part in 16, is not official. An emulsion is made with spirit, glycerin and water (v. p. 119). *Iodo-vaseline* (not official) consists of 1 dr. of iodoform in 1 oz. of eucalyptus oil—and 5 oz. of vaseline. *Kieselguhr*, a diatomaceous earth which is very absorbent, mixed with iodoform makes a good dusting powder. *Iodoformum bituminatum* is a combination with tar (B. M. J., ii., 1888). Bougies, insufflations, gauze, lint, wool, plasters and pastilles, are prepared.

ADMINISTRATION.—The disagreeable smell of iodoform may be covered by ethereal oil, such as that of peppermint, eucalyptus, or geranium (but combination with essential oils may give rise to acrid products): also by Tonquin bean (cumarin), by *oleum pini sylvestris*, by *sanitas*, by oil of camphor, or coffee. Otto of roses (m j to 3 j) is good, also a combination of quinine and charcoal, but tinct. benzoin. co. is sufficient for most cases.

ADULTERATION.—It may be adulterated with picric acid, which is cheaper, and has the same melting-point as iodoform.

OTHER IODISED COMPOUNDS. (Not Official.)

Antiseptol, Iodo-sulphate of cinchonine, is a brown powder, free from odour, insoluble in water, soluble in spirit and chloroform, containing 50 per cent. of iodine (Therap. Gaz., 1890).

Aristol, Di-thymo-iodide, is a reddish-brown powder, insoluble in water and glycerine, soluble in ether and oils, decomposed by heat and light, contains nearly 46 per cent. iodine, neither irritant nor toxic, used in powder or ointment 5 to 10 per cent. in various skin diseases, etc. (B. M. J., 1890-91); 3 per cent. with 20 of olive oil and 77 of lanoline is a good application for burns, etc.

M. Brocq has treated epithelioma of the face having a large ulcerated surface, with pulverised aristol. Good results followed in five or six days; and a tendency to cicatrisation was observed. Twenty days afterwards it was far advanced, and in a few more days was complete (B. M. J., i., 1890). Eichhoff found this drug equal to iodoform in all cases in which he tried it, except in soft chancres. It acts more slowly than chrysarobin or pyrogallie acid in psoriasis, but has some advantages over the former drug. In parasitic skin diseases it is equal to other remedies, and is not so irritating. In ulcers of the leg and in tertiary ulcerations it

“heals more quickly than any other known medicinal application,” and he considers that in lupus it surpasses all remedies hitherto tried; he uses a 10 per cent. ointment with vaseline (Monats. f. prakt. Derm., No. 2, 1890). Dr. Edward Mackey speaks very favourably of this, which he increases to 15 per cent.

Europhen, iso-butyl-ortho-cresyl-iodide, is a yellow powder, insoluble in water and glycerine, soluble in oil, spirit, etc., resinous to the touch, and with slight odour like saffron, containing 28 per cent. of iodine, decomposed by heat and light, is much lighter than iodoform, non-toxic, and acts only when in contact with moisture (B. M. J., ii., 1891, and i., 1892, etc.); it is especially useful (1 to 10 per cent.) in soft chancre.

Iodol, tetra-iodo-pyrrol, a brownish-white powder, insoluble in water, soluble in spirit, more so in ether, collodion, and chloroform, moderately in glycerin, is non-toxic and odourless, but gives off iodine on heating. It can be used as an ointment rubbed up with vaseline or lanoline, as a powder dusted over the affected parts, or as a solution in alcohol diluted with glycerine or dissolved in warm oil. It was found useful in indolent ulcers, which soon took on a healthy action; also after excision of suppurating inguinal glands it proved an excellent dressing (B. M. J., i., 1887). It is used as an ointment in eye and ear diseases. *Loretin* is an iodine compound with chinolin and sulphonic acid, yellowish, crystalline, free from smell, slightly soluble, non-toxic, with much power over pus-formation (Snow, B. M. J., ii., 1895).

Iodo- and *di-iodo-salicylic acids* are white powders combining both drugs (Bull. Gén. Thérap., 1889).

Sozoiodol, di-iodo-para-phenol sulphonic acid, contains 54 per cent. of iodine, with sulphur and carbolic acid, and has been combined with sodium mercury and other metals to form salts: that with sodium is in odourless acicular crystals, soluble in water: dose, 10-20 gr. twice or three times daily in diabetes, syphilis, etc. Externally it is used in a 5 per cent. solution for ophthalmia and rhinitis, or in powder with $\frac{1}{2}$ milk-sugar for nasal catarrh, laryngeal ulceration, pertussis, etc., or even in a concentrated state without creating inflammation.

Among other substances used as substitutes for iodoform are di-iodoform or ethylene per-iodide; eka-iodoform, a combination of paraform and iodoform; iodoformal, iodoformin, losophan, noso-

phen and sanoform, and calcium iodate. The sodium salt of nosophen is "antinosin," a blue powder used in 2 per cent. solution as an antiseptic wash for mouth and nasal disorders, catarrh, etc. A non-staining iodine 5 per cent. ointment is called "kelpion".

Periodate contains periodic and iodic acids combined with calcium, and is a whitish powder, free from smell and slightly soluble in water.

BROMUM—BROMINE, Br = 80 (79·35).

Not Official.

This element does not occur free in nature, but its compounds with metals (bromides) are contained in sea-water and in some saline springs, as in those of Ashby, Birtley (Durham), Woodhall, Crieff, and Kreuznach, also in sea-weed and molluscs.

CHARACTERS AND TESTS.—Bromine is the only non-metallic element which is liquid at ordinary temperatures. It is of brownish-red colour, very volatile, and emits an irritating, disagreeable vapour, whence its name *Βρωμος*, a stench. It should be kept in a closely stoppered bottle. It boils at 135° to 140° F. Alkalies decolorise it, with formation of bromides and bromates; with hydrogen it combines to form hydrobromic acid (HBr). Solutions in alcohol and ether (which liquids dissolve bromine readily) lose their colour in a few days with formation of the same acid. At 32° F. it forms with water a crystalline hydrate. When agitated with solution of soda in such a proportion that the fluid remains very slightly alkaline, it forms a colourless liquid which, if coloured by adding a small quantity of the bromine, does not become blue on the further addition of starch solution, thus showing the absence of iodine.

PHYSIOLOGICAL ACTION.—Bromine coagulates albumin and combines with it in a definite proportion of Br. 23, albumin 96, which compound is soluble in caustic potash, and is colourless (Glover, Harveian Essay, 1842).

Undiluted bromine quickly oxidises and destroys organic tissues, forming a brownish slough; with fatty substances hydrobromic acid is developed. Bromine vapour is intensely irritating to the air-passages, it may cause coryza, or even laryngitis, bronchitis, or pneumonia, and may destroy the sense of smell. (Hot-water vapour has been used as antidotal to this and other halogens.) It is a powerful disinfectant, but on account of its

odour is but little used as such. Dr. Warmick exposed silk fibres, impregnated with anthrax spores, for six hours to bromine fumes from siliceous earth impregnated with seven times its volume of bromine, and found, by experiments on mice, that the virulence of the bacillus was destroyed (Lancet, i., 1882). The disinfecting powers of bromine have been also applied to the sterilising of water: if 20 grammes of it and of potassium bromide be dissolved in 100 grammes of water, 0·2 gramme of this will sterilise a litre of water and it may then be neutralised by adding ammonia (Lancet, i., 1897).

When taken internally in doses of 1 to 2 drops, well diluted, it has a taste "truly horrid" (Glover), and causes weight and heat at the stomach, often colic, shooting pains in the limbs, and itching in the extremities; but after an hour or so these symptoms are succeeded by a general sense of comfort and stimulation. Larger doses may cause gastritis with symptoms of intense irritation, prostration, and collapse. Independently of this local irritant effect, the physiological action of bromine, after absorption, is exerted mainly on the lymphatic and glandular systems, their functional activity being increased, though to a less degree than by iodine.

Köhler mentions several experiments which have been made with bromine, and says that, "independent of its local irritant action, it exerts, if taken in small doses for some time, a strong action upon the brain, *viz.*, depression of the mental functions, sleepiness, stupor, prostration, and a state resembling alcoholic intoxication."

THERAPEUTICAL ACTION.—*External.*—**Hospital Gangrene.**—**Erysipelas.**—The value of bromine as an escharotic and caustic in these maladies was conclusively shown during the American civil war by Surgeon Goldsmith. The formula commonly employed was—"bromine 1 oz., bromide of potassium 160 gr., water 4 oz." After thorough cleansing of gangrenous wounds this was applied; and, although very painful for a time, the pain was mitigated by bathing, and the malady was arrested more surely by this than by any other means (Med. Times, ii., 1863). The same application was found valuable in diphtheria and erysipelas, and the liquid, when exposed in shallow vessels, served also to disinfect hospital wards.

Mr. Marshall and Mr. Southam used a solution of 1 scruple of bromine in 1 oz. of spirit for unhealthy wounds, and found it useful, but very painful; its offensive smell is also a drawback to its employment. The pure drug has been applied, and acts well in similar cases, but requires special precaution to carry the vapour away from the patient (*Lancet*, ii., 1868).

Chancre.—Epithelioma.—In the few cases where a chancre can be, with advantage, destroyed at an early stage, bromine is one of the most efficient agents for the purpose.

Dr. Wynn Williams and others have reported very satisfactory results from the use of bromine injections into the substance of epithelial cancer affecting the cervix uteri, a solution of 12 min. in 1 dr. of rectified spirit being injected through a speculum by means of a long glass syringe having a platinum point; the nostrils of the operator and patient should be plugged with cotton wool (*Med. Times*, ii., 1866 and 1870). Good results were obtained by Dr. Williams, but as he restricted his method to cases "in which the uterus was not fixed," doubts were thrown on the diagnosis of cancer by Dr. Playfair and others.

Endometritis.—More recently the vapour of bromine has proved valuable in acute endometritis, sprayed by an atomiser over the inner surface of the uterus, a double current catheter being introduced (*Nitot, La Gynécologie*, Oct., 1897; *Amer. Journ.*, i., 1898).

Nasal Catarrh.—Hay Asthma.—Ozæna.—Brominised inhalations are of value in these disorders, and may be employed in the manner recommended by Bartholow. Half a drachm of bromine is mixed with 4 oz. of alcohol, and a small quantity of this placed in a wide-mouthed phial and vaporised by the warmth of the hand, furnishes a diluted vapour which should be drawn up into the nasal passages.

Diphtheria.—Similar inhalations have been successfully used, especially by German physicians, in this malady, and in diphtheritic vaginitis (*B. M. J.*, ii., 1872). Ozanam used also an aqueous solution internally (*Brit. and For. Rev.*, 1869), and I have myself seen excellent results with this combined method of treatment, diphtheritic membrane disappearing under it. I have employed the inhalations of bromine internally every three or four hours, using one or two drachms of a solution containing

eight drops to the ounce, even when the disease had extended to the bronchi and great prostration had set in, and sometimes I have used the vapour and local applications of bromine whilst giving iron internally, also with very good results.

Redenbacher has reported two successful cases in which bromine and bromides were useful (B. M. J., i., 1879).

COMPOUNDS OF BROMINE.

POTASSII BROMIDUM—BROMIDE OF POTASSIUM

(KBr = 119).

CHARACTERS AND TESTS.—It occurs in cubical crystals resembling those of the iodide, but smaller. When well kept they are transparent or white, but sometimes have a tinge of yellow from free bromine. They have a saline bitter taste, high diffusion power, and are very soluble in water. Chlorine water added to the crystals liberates bromine, which will impart an orange-red colour to chloroform, ether, or bisulphide of carbon. The starch test would detect iodine, which used to be a frequent adulteration. Bromides give a yellowish-white precipitate with silver nitrate, which is sparingly soluble in ammonia solution.

AMMONII BROMIDUM—BROMIDE OF AMMONIUM

(NH₄Br = 98).

CHARACTERS AND TESTS.—It occurs in white, colourless crystals, which gradually become yellowish on exposure to the air; they are readily soluble in water, less so in spirit. It is rather more disagreeable to the taste than the potassium salt.

SODII BROMIDUM—BROMIDE OF SODIUM

(NaBr = 103).

CHARACTERS AND TESTS.—It is a white powder consisting of small monoclinic crystals, with a saline taste, readily soluble in less than twice its weight of water, much less soluble in spirit (1 in 13).

The following are not official:—

Lithii bromidum—bromide of lithium is a white, granular, deliquescent salt, very soluble both in water and alcohol, and containing a larger proportion of bromine than any other mineral compound.

Calcii bromidum—bromide of calcium is a white, soluble,

deliquescent salt, which readily decomposes on exposure, becoming brown in colour; it occurs in Kreuznach and Vals water; is less stable than the potassium salt (Hammond).

Magnesi bromidum—bromide of magnesium. This salt is the main source of the metalloid, and is especially abundant in the water of the Dead Sea; it is found also in the Ashby and Kreuznach waters.

Strontii bromidum—bromide of strontium occurs in lumps of small white crystals, very soluble in water; said to be less toxic and better borne than the alkaline bromides (B. M. J., ii., 1891; i., 1892); contains $\frac{1}{3}$ less bromine than the potassium salt (*cf.* Year Book, 1893).

Sodium hypobromite. An alkaline solution of this salt is employed in the estimation of urea (Dupré's method).

Bromum solidificatum; a variety of earth called Kieselguhr, has been impregnated with bromine in different proportions, compressed into sticks, and sold under the above name (American Druggist, Jan. 1887).

There are besides bromides of lithium, gold, iron, zinc, mercury and lead; and many *organic* bromides and hydrobromides, such as those of caffeine, camphor, morphine, quinine, and strychnine; also of ethyl and ethylene (Therap. Gaz. 1891). Their properties are chiefly those of the base, but modified somewhat, so as to act more favourably on the nervous system. Bromates have also been used.

Bromol, tri-bromo-phenol, is a white crystalline substance, insoluble in water, soluble in ether and oils, used as a disinfectant like bromine (Lancet, i., 1891).

Bromoform—terbromide of formyl, CHBr_3 (analogous to chloroform), is obtained by the action of bromine on alcohol, in presence of an alkali, and is a clear liquid of ethereal odour, sp. gr. 2.9, soluble in alcohol and ether, slightly so in water; of sweet taste, and non-irritant. It is decomposed by light, bromine fumes being given off, and the colour turning brown.

Bromal hydrate, prepared like chloral hydrate but with bromine vapour, occurs in colourless crystals which melt readily on the hand to an oily irritant substance, which has a strong smell and burning taste: it has narcotic and heart-paralysing effects somewhat like chloral, but is more toxic.

Bromalin or *Bromethylformine* is an organic bromide introduced in hopes of avoiding the acne and dyspepsia so often caused by other combinations, and there is some evidence of its successful use (Lagner, *Nouveaux Remèdes*, No. ii., 1895). It occurs in colourless crystalline scales or powder, soluble in water without metallic taste, and the ordinary dose is about double that of the potassium salt.

Bromipin (Merck) is a combination of bromine with sesame oil, utilised for the same object. It cannot be broken up by alkalies, even with boiling, but is slowly decomposed in the bowel: one drachm of the 33 per cent. solution contains bromine equivalent to 30 gr. of potassium bromide, and may be given in syrup, emulsion, capsules or per rectum or subcutaneously (Hesse, *Allgem. Med. Cent. Zeitung*, 1900, No. xxi.).

ABSORPTION AND ELIMINATION.—The alkaline bromides are readily absorbed, and have been found in the urine and saliva five minutes after a dose of 15 gr. (Rabuteau); in ten minutes' time the reactions were very manifest. Bowditch drew blood from the carotid of an animal six minutes after 10 gr. had been taken, and calculated that even in that time a third of the dose had passed into the circulation (*Boston Med. Journ.*, 1868). They are usually eliminated *unchanged*, and Voisin has obtained cubical crystals of the potassium salt from the urine of patients taking it,—which contradicts the usual statements that all bromides become sodium bromide in the digestive tract.

The rate of elimination varies. In some experiments the urine gave traces of the drug in ten minutes; in others thirty minutes was the earliest period; in others twenty-five hours (Bowditch). The excretion of single large doses is usually complete in one or two days (Chauvet, Amory), though minute quantities have been detected in the urine for three or four weeks afterwards (Rabuteau). If the drug has been taken continuously for some time, the period of its excretion is prolonged: thus Namias found it continue for fourteen days (*Gaz. Hebdom.*, 1868), and renal disease so far impedes its excretion that upwards of thirty days may be required for its completion. Dr. Stevenson “detected bromides in the urine of a child four weeks after the medicine was discontinued” (*Path. Soc. Trans.*, 1877).

As evidence, also, of the slow elimination of these salts, Drs. Crocker, Lees, Barlow, I myself, and others have noted the increase, or even the chief development, of the rash sometimes produced by them, after the discontinuance of the drugs. The elimination of bromides is certainly slower than that of iodides. It occurs not only by the kidneys and salivary glands, but also by the mammary, lachrymal, and sudoriparous glands, and by mucous membranes—by the last especially in the case of the ammonium salts. In exceptional instances the salts have been decomposed in the system, and free bromine eliminated in the breath. The alkaline compounds do not usually pass by the fæces unless diarrhœa occurs; but if bromides of the heavy metals be taken the *metal* passes chiefly in the motions.

Thus, when experimenting with bromide of iron, Namias found bromine abundantly in the urine, but iron scarcely at all. The same observer, examining the body of a man who died whilst taking bromide of potassium, found that salt in all the fluids, as well as in the brain, liver, lungs, and other viscera (*Comptes Rendus*, t. lxx.). After very large doses an unabsorbed portion has been found in the intestine. M. Doyon found a considerable amount in the *brain* (30 gr.), and in the liver (11 gr.) of a child who had taken large quantities for about twelve months (*Lyon Méd.*, 1889). Fessel noting that “bromism” occurs only sometimes in patients taking it, explains this by the large amount often retained in the system, and says that the excretion only becomes equal to the intake when the system is saturated; many weeks after the drug has been stopped he has found elimination continuing slowly by the kidneys, and more or less by all secretions; the excretion of chlorides is also augmented, whence he concludes that bromides oust them to some extent from their combinations in the tissues and fluids (*v. p.* 137). Hydrobromic acid if long given largely replaces hydrochloric acid in the gastric juice, and sodium chloride increases and accelerates the excretion of the bromide. He found the salt most in the blood serum and corpuscles, the brain and kidney, less in the liver and spleen, and thinks it combines with nerve substance in the brain and cord (*Münch. Med. Woch.*, Sept., 1899).

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—Doses of 5 to 15 gr. of the alkaline bromides are well

borne by the stomach, but 20 to 30 gr. will often cause irritation and nausea, with sense of weight and coldness, later of warmth. At first the gastric secretions are rather lessened and appetite slightly increased, but after a time there is anorexia, and gastric catarrh and diarrhœa may occur, especially with the potassium salt. It has been said that such symptoms, as also cutaneous eruptions, are mainly due to a septic condition of the gastro-intestinal tract, preventing proper assimilation, and may generally be obviated by combining an antiseptic, such as naphthol or salicylate, with the bromide (Féré, Soc. de Biol., 1891). The same observer records one case taking daily 150 grains of the potassium salt, in which an eruption persisted in spite of asepsis, but with the same dose of strontium salt no eruption occurred. Bromide of sodium increases thirst as the chloride does. The sensibility and the reflex movements of the *fauces* and *pharynx* become much lessened under the full influence of the bromides, and even from their continued local application, so much so that in certain cases the fauces may be tickled without causing any tendency to vomit; if, however, these parts are inflamed, a strong solution may prove painful.

Nervous System.—The action of bromides on the nervous system, especially of the lower animals, has been carefully studied by many observers, but with different and somewhat confusing results. Thus, whilst Damourette, Pelvet, and R. Amory conclude that the functions of nervous tissue become paralysed by its direct local application (Bulletin Thérap., t. lxxiii., and Essay on Bromide, 1872), Saison finds no trace of such paralysis (Du Bromure, Thèse, 1868); and whilst Laborde and Purser are satisfied that reflex function is abolished early (Archives de Physiol., t. i., and Dub. Journ., 1869), Bill holds this to be unproven, and argues that results with frogs are but little guide to effects on men (Amer. Journ., July, 1868).

I believe, however, that in this instance there is much analogy in the action of the drug on men and animals, and a careful consideration of the evidence before us warrants the following statements.

In *batrachians*, the bromides, when injected under, or absorbed through the skin, exert a local paralysing effect on the neighbouring tissues, whether nervous or muscular. If the injection

be made close to the brain or to the cord, the *centre* which is *nearest* will be paralysed soonest; but if absorption occur at a distance, *e.g.*, through the web of foot, then *reflex power* is *first* lost, so that pinching or irritation does not excite the usual contractions. The other peripheral sensory nerves lose their sensibility very soon afterwards; then the motor tract of the cord and motor nerves are affected, and lastly the cerebrum. Most of the characteristic effects of the drug may be seen on frogs after the medulla is divided from the brain, but if it be left undivided, the persistence of some cerebral action, after the cessation of reflex function, is made evident by movements.

In *warm-blooded animals*, the demonstration of early loss of reflex power is not so complete, but there is evident impairment of sensibility and of cerebral action, with partial paralysis, especially of the *hind* limbs.

In *man*, the earliest effects of *full* doses on the nervous system are usually seen in impaired sensibility, especially of the mucous surfaces, such as the fauces and pharynx, the conjunctiva, and the urethra. It is possibly most marked in these regions because the drug is largely eliminated there, but loss of tactile sensibility is also sometimes observed in the palms and the soles: reflexes are weakened. Affection of the nerve-centres is shown, sooner or later, by languor, lassitude, tremor and drowsiness; giddiness is complained of, and exceptionally there may be cerebral excitement; mental working power is temporarily impaired, so that simple matters become puzzling, and memory fails. Both Weir Mitchell (1896) and Hare (Therap. Gaz., 1893, 1897) have specially drawn attention to alterations of character and thought in the direction of irritability, suspicion, melancholia and even suicidal impulse, kleptomania and delusions, sometimes sexual. The amount of the drug that produces such symptoms varies in different persons. Dr. Lockhart Clarke has noted them after half-drachm and drachm doses, but usually they are not seen until after much larger quantities have been absorbed. The impaired condition of the nervous system is known as "bromism," and when developed in an extreme degree, the special senses, sight and hearing, are greatly dulled, reflex and motor power are almost wholly lost, and the cerebral state is one of absolute apathy and indifference bordering upon idiocy. As a rule, these serious symptoms subside

quickly on omission of the drug, but death has resulted from an overdose in the case of a child, who accidentally drank a mixture which contained 80 gr. of bromide of potassium; narcosis ensued, and the child died about an hour afterwards (Duncan, B. M. J., i., 1882). In seeking for an explanation of the *mode* of action of bromides, it is clear that the contraction of the minute vessels in nervous tissue will not account for all the phenomena observed. The drug produces in certain doses such a contraction, due either to the stimulation of vaso-motor nerves, or of the muscular coat of the vessels; but the chief effect is directly sedative and depressing on the cerebro-spinal centres, especially the cortex (Wright), as well as on the peripheral nerves, including, in some instances, the vaso-motor nerves, as is shown by the relaxation of the small vessels, and local congestions which occur in certain cases. It is thus that we may explain the exceptional occurrence of diarrhœa or diuresis under bromides, and more particularly the retinal congestions found by Dr. Nicol after doses of $\frac{1}{2}$ to 1 dr. (Med.-Chir. Trans., ii., 1872); this point, however, requires further investigation.

Nothnagel says the temperature always falls after large doses in men and animals—after 10 grammes ($2\frac{1}{2}$ dr.) by 0.5° to 0.8° C., after 15 grammes by 1.2° C.

Circulatory System.—In the frog, if strong solutions be injected near the cardiac region, the heart is suddenly arrested in diastole, but under a slower *distal* absorption this does not occur, nor is there evidence of the specific paralysing effect upon the heart contended for by Eulenburg. On the contrary, the heart has been found beating one or two hours after complete paralysis of the nervous system and of respiration (Damourette, Saison). Drs. Ringer and Sainsbury, in their investigations on the frog's heart, found that potassium bromide arrested that organ in diastole, in which action it resembles chloral and morphine. From this they draw the practical conclusion that it is unsafe to give the drug in conditions of great adynamia (B. M. J., i., 1883). The heart's action is rendered slower, but, as a rule, the capillaries are narrowed *before* this slowing. It is not the soaking of the cardiac muscles with bromide of potassium that produces these effects (as it does in the experiments on the frog mentioned above), but the gradual lowering of the spinal reflex activity. The ob-

servers just named, as well as Meuriot, Hammond, and Amory, have witnessed the narrowing of vessels in the web, the tongue, and the brain of frogs or dogs, but others have failed to see this, and Dr. H. C. Wood considers the present proof insufficient; neither does the observation that the divided capillaries of a brominised frog bleed less than normal ones seem free from criticism, for he suggests that lower cardiac action would account for lessened bleeding. But, these observations apart, I think the pallor of the surface that follows the use of bromides, and the lessening of secretion and discharge, point strongly in favour of the view that the vessels are narrowed. There is also post-mortem evidence that the blood in the capillaries is lessened under the influence of bromides (Saison), and we may quote, too, the clinical fact that bromides relieve many forms of *capillary congestion*, especially cerebral and uterine, whereas in patients with cerebral *anæmia*, the effects are often distressing. Thus, whilst Dr. Wood considers capillary contraction to be "somewhat probable," I hold it to be clearly ascertained.

That the heart's action and the general circulation are slowed in the lower animals is also evident from many experiments (Damourette and Pelvet, *loc. cit.*, and Schouten, Schmidt's Jahrb., Bd. cliv.). This is more marked with the potassium salt than with the others, and may be largely credited to the alkali; the bromide of sodium has comparatively slight effect in this direction (Eulenburg, Rabuteau). In man, the depressing effect of any bromide on the circulation is not constant; Pletzer noticed it (Schmidt's Jahrb., 1868), and Bartholow records a depression of 10 to 20 beats per minute after a dose of 2 dr., but Dr. Bill, Dr. Voisin, and others have failed to observe such a result with doses of 20 gr. and upwards continued for some time. It is evident that the depressing effect of the bromides is less on the circulatory than the nervous system; but a case of death from cardiac syncope is recorded after the habitual taking of 2 to 3 drachm doses of the potassium salt, and is attributed to it: the evidence is not, however, very positive (Lancet, i., 1896). Dr. Macphail, in his essay on the blood of the insane, stated that the administration even of large doses of potassium bromide does not impoverish the blood. Dr. J. A. Campbell notes, however, a disposition of those taking large quantities to hypostatic congestion of the lungs (Lancet, ii.,

1885). This probably is a result of the action of the drug on the circulation, not on the blood itself.

Generative System.—Speaking generally, we may say that bromides act as sedatives upon the genital system, and diminish the sexual feelings and the power of erection, though the secretion of the testicles is not lessened (Rabuteau). Genital excitement may arise either from *eccentric* cause (as urethral irritation, rectal or ovarian congestion, etc.), or from a *centric* cause in the cord, or brain itself. Both are controlled by bromide, the effect being partly local, and exerted through the mucous membrane of the urethra, and partly due to a lessening of congestion and depression of functional power in the spinal cord. The degree of sexual sedation induced by bromides varies in different men and animals, and any marked effect of the kind is shown only under the influence of large doses.

Action on Secretion and Excretion.—The *primary* effect of moderate doses of bromide is to lessen most of the secretions (Bowditch and others), although, as a *secondary* effect, or after very large doses, they may be increased. There is no lachrymation, salivation, or catarrh from a pure salt, as there is from the iodides, for bromides are more stable, and although also eliminated by mucous membranes, do not part with free bromine on their surface. The mouth is rendered rather drier than usual, especially by the sodium salt. The amount of mucous in the intestinal canal is also lessened, so that constipation is not infrequent at first. The secretion of milk is lessened by the internal and local use of bromide of potassium (Tyler Smith, *Med. Times*, i., 1861). With regard to the amount of urine excreted, the usual result is that with small or moderate doses no increase can be made out, whilst with large or long-continued ones, diuresis occurs. Dr. Bowditch suggests that a *secondary* hyperæmia is produced more readily in the kidneys than in other parts, and Pletzer has reported albuminuria in some instances.

Bromides tend to lessen vesical irritability, and so to render micturition less frequent, though the amount passed may be really larger than usual. On the other hand, very large doses may so far paralyse the sphincter as to occasion incontinence.

Excretion of Urea and Carbonic Acid.—**Action on Nutrition.**—From the experiments of Drs. Bill and Rabuteau, it appears

that tissue-change is *retarded* under the influence of bromides. The former especially noted that the carbonic acid eliminated was decidedly less than normal, and this independently of diminished nervous power, and not proportionately to the dose, as it is with morphine and its congeners.

Rabuteau found that whilst his average daily excretion of urea was 21.25 grammes, the mean amount passed whilst he took a daily dose of 15 gr. of bromide of potassium was 19.52 grammes; for a fortnight after omitting the drug it remained at about 20 grammes; in the third week it resumed a normal proportion, and in the fourth week exceeded this. Rabuteau connected the primary result with slowing of circulation and respiration; it was not accompanied by increased secretion of urine.

Dr. Gibb also found that the ammonium salt in small doses (3 to 5 gr.) diminished body-weight "by favouring absorption of fat" (Lancet, i., 1863). Bartholow found that assimilation was *retarded* by the continued use of bromides, and he traced emaciation to this cause. I have sometimes noted it from these medicines; but it is by no means invariable.

Cutaneous System.—Perspiration is diminished under bromide of potassium. Various kinds of *eruption*, erythematous or acneform in character, are commonly traced to this drug, and although several observers maintain that they are wholly due to *iodide* contained in the preparation, they seem in greater or less degree inseparable from bromide medication, and occur with almost equal frequency after the ammonium, sodium or other compounds. Erlenmeyer, advocating the use of several bromides in combination, makes the curious statement that acne produced by one often disappears if change be made to another, though given in equivalent dose (Record, 1885).

The eruptions affect mostly the face, arms, back and buttocks, but may be general. They present papules, vesicles containing sebaceous matter (seborrhœa—Fox), or pustules, and even crusted tubercles of carbuncular character, and have been termed "confluent acne" (Cholmeley) and "molluscoid acne" (Neumann). Voisin distinguishes five different kinds of "bromide rash" (Archives Gén., 1866-67). Usually there is a hard, red swelling, with a small point of suppuration in the centre: this may be quite small—a mere papule—or of large size. An eruption of this kind has

occurred in a child at the breast, whose mother was taking the medicine and was not herself affected (*Lancet*, ii., 1874). A more rare, but still recognised form, is that of erythematous patches, which may be local or general (*Med. Times*, ii., 1874; i., 1878). The microscopical examination of the pustules produced by bromine shows that the pathological anatomy is not the same in all cases. Mr. Waren Tay and Dr. Stephen Mackenzie found, in a case in which the eruption resembled chicken pox, pus cells in the corium, especially around the hair follicles and sebaceous glands; the blood-vessels were distended; the sweat glands were not affected (*Lancet*, i., 1884). Dr. Colcott Fox found in another case that the blood-vessels and sweat glands were chiefly implicated, while the hair follicles and sebaceous glands escaped (*Lancet*, ii., 1885).

The occurrence of such cutaneous eruptions in the medicinal use of the drug is (as in the case of iodide rashes) obviated to some extent by giving small doses of arsenic subcutaneously (Gowers, *Lancet*, i., 1878) or, as is more usual, with the bromide mixture.

Dr. Cameron has experimented with bromates, especially that of quinine, and finds that they are physiologically more active than bromides. This corresponds to his results with the iodates, which are more active than the iodides: the reason he assigns is the same in both cases, namely, the larger molecular weight and the "superoxidised" condition of the former compounds (*Lancet*, i., 1882).

SYNERGISTS.—The sedative action of the alkaline bromides on the nervous system is assisted or modified favourably under certain conditions by chloral, chloralamide, cannabis, and opium; their regulating effect upon vaso-motor nerves especially by quinine; their depressant effect upon the circulation is aided by aconite, gelsemium, veratrum viride, and digitalis, also by potassium nitrate and allied salts; their alterative power is increased by cod-liver oil, iodides, and alkalies.

ANTAGONISTS.—Stimulants, such as alcohol, ether, and coffee, oppose the action of bromides; thebaine, strychnine, and nicotine are also antagonistic. Strychnine especially has an opposite effect on the cord and the medulla oblongata, though without a direct action on the brain or the muscles. The difference in the capillaries of the spinal centres post mortem, after

using the two drugs, was especially noted by Saison; under bromide the vessels were scarcely visible, under strychnine intensely congested.

Atropine antagonises in some degree bromal hydrate (Hughes Bennet, B. M. J., i., 1875), and ergot is opposed, in its full action, to bromides—although any of the above-named drugs may at times be usefully combined with them, and made to modify their ordinary action for certain therapeutical results.

Dr. Bill argues that chloride of sodium is antagonistic to bromide of potassium, and that the latter remains longer in the system if the former salt be avoided (Amer. Journ., 1868), (*v.* p. 129).

THERAPEUTICAL ACTION.—*External.*—**Morbid Growths, etc.**—Bromide of potassium, applied in fine powder to indolent ulcerations and morbid growths with raw surface, is said to act well and painlessly as an alterative or caustic (Med. Times, ii., 1876). Mixed with simple ointment (1 part in 5), or with glycerin, it forms a sedative, somewhat astringent application for painful and sloughing ulcers, also for painful conditions of mucous membranes, hæmorrhoids, and anal fissure, and for chronic eczema and acne.

THERAPEUTICAL ACTION.—*Internal.*—In 1826, Barthez, Andral, and other observers, ascertained that the potassium bromide could relieve arthritic pain, and Pourché found it useful in bronchocele. Dr. Robert Williams (of St. Thomas's Hospital) reported such success with it in the treatment of enlarged spleen as to contribute to its introduction into the London Pharmacopœia of 1835, and yet it is instructive to remark that so little clinical evidence of its value was obtained by others that the medicine was omitted in that of 1851. Puche noted from it partial anæsthesia; and Thielman, a Russian physician, its sedative influence on the generative system; from these suggestions Sir Charles Locock was led to use it in epileptic or epileptiform attacks, connected especially with ovarian disturbance, and the mention of his successful results at the Medico-Chirurgical Society, in 1857, was practically the commencement of general knowledge on the subject.

Epilepsy.—For this malady the bromides are now, by common consent, held to be the most trustworthy remedies. They give

the best results in *sthenic* cases of uncertain causation, when convulsive attacks are very violent but have not become chronic. Attacks connected with tumour, or injury, or organic lesion, are also more or less relieved. When there is *eccentric* irritation, as in the generative system or the abdominal organs, benefit is almost always obtained, and Dr. Bill has compared the action of bromides in such cases to that of a ligature, interrupting communication between an impression or "aura," and the brain; they seem to diminish not only conductive, but reflex function. In a case in my own practice where a large uterine fibroid was associated with epileptiform symptoms, opium invariably increased the spasms, but bromides relieved them quickly.

Minor forms of epilepsy, as "petit mal," evidenced by transient vertigo or loss of consciousness, with perhaps some spasm, but not true convulsion, are not so certainly relieved; and when the epileptic attacks occur only, or chiefly, at *night*, and at *long intervals*, bromides are not always the best remedies; also in very chronic cases of many years' duration, they can usually do little more than modify the character of the attacks. When the patient has become nerveless and stupid, belladonna has the advantage over bromides, and when there is marked anæmia, or profound depression, they are not desirable. Nux vomica, or strychnine in small doses, will act better, especially in anæmic cases and if consciousness be not completely lost during the fits. It must be noted, however, that according to statistics published by Dr. A. Hughes Bennet, all varieties of the disorder—petit mal, nocturnal and chronic epilepsy—have shown good results in large proportion under bromide treatment (Edin. Med. Journ., 1881).

Supposing the case be one suitable for this treatment, it is important for success that it should be carried out thoroughly, in sufficient doses, and continued sufficiently long. It must not be interrupted as useless in any case, unless distinct evidence of its physiological effect has been obtained without relief to the symptoms. The production of drowsiness, or of a characteristic skin-eruption, may be taken as some guide, but a better one will be found in the absence of reflex irritability in the fauces; if no irritation or retching is caused by touching the uvula or pharynx, then probably the patient is under bromic influence. From 10 to

40 gr. thrice daily is an average limit, more being given at night-time if necessary ; in cases where nocturnal attacks occur, a double dose just before going to bed is found to be useful. At first, even larger quantities may be required, and many instances of success from very large doses are on record. Puche and other French physicians have given 100 and 200 gr., but not without some vomiting and prostration (Med. Times, i., 1874). Dr. Squibb found 60 gr. act well when less failed, and he notes that if the medicine needs to be omitted for a time, it should be resumed at the full dose again. Dr. Farquharson gave 30 gr. four times daily with benefit to a child, aged five ; and Dr. F. Beach at the Clapton Asylum, commonly gave 15 gr. every two hours for a time, and 1 or 2 dr. during a paroxysm (B. M. J., ii., 1877). Thirty grains thrice daily have been taken for twelve years, and although before treatment the patient was incapable of work, he became equal to the conduct of an ordinary business (*ibid.*). There was no effect on the sexual power. I have often myself given similar large doses, and for a long period, but there is no *one* rule to follow, as I have found 10 gr. act as effectively in some cases as 60 gr. in others. Sometimes 5 gr. will cause troublesome acne.

When the attacks are once controlled, a single daily dose of from 20 to 60 gr. will usually suffice to keep up the effect, and may have to be continued for many months or years. Bromide, indeed, has been well called the "food of the epileptic," and sometimes needs to be taken as regularly as food ; still, an occasional intermission—one or two days in a week or fortnight—is usually desirable, for thus the effect of the medicine is better preserved with less injury to the patient. It is necessary to watch carefully its effect on the general health, and to omit it, or at least to lessen the dose, if the skin should be much affected, the extremities become cold, or anæmia, prostration, or diminished sexual power be traced to it. In exceptional cases there has been developed, under bromides, a peculiar general irritability of asthenic character, or even an excited condition resembling mania (Sequin, Voisin ; *v.* p. 131). Minor symptoms, such as headache, "stuffiness" of the head, lachrymation, and gastric irritation, have been connected with the use of a preparation adulterated with *iodide* (Med. Times, i., 1872). If during the omission of treatment convulsions

threaten to return, bromide should be at once resumed, but perhaps in a different combination.

For weakness or anæmia, quinine or iron may be added with advantage. Strong coffee hinders the development of bromism (Echeverria), and arsenic in small doses will lessen or cure bromic acne. Several alkaline bromides taken together sometimes act better than any single one (Brown-Séguard), and I have often found advantage from combining the potassium and ammonium salt (*v.* p. 144). General experience has not yet corroborated the observations of Weir Mitchell as to the superior efficacy of the lithium salt, nor of Hammond as to the bromide of calcium, but they may be useful as alternatives. The bromide of sodium is less depressing to the heart than that of potassium.

I cannot speak well of the addition of belladonna, often recommended; when given in combination with bromides, I have found its action unreliable and confusing. Dr. Beaman combined lactucarium and lupulin with bromide (Lancet, ii., 1867), and the addition of digitalis has been found valuable (Lancet, ii., 1871). I have myself seen excellent results from the last-mentioned combination in epilepsy connected with masturbation or nocturnal emissions; it has marked control over such conditions. I find it best to give the digitalis separately, morning and afternoon, and the bromide at night, and have found this treatment stop the onanism and emissions, and cure the epilepsy. The infusion of digitalis is the best preparation, and should be given in $\frac{1}{2}$ to 1 dr. doses.

Charcot recommends the bromide of zinc (B. M. J., ii., 1877), and Bourneville the bromide of camphor (*ib.*, i., 1877). I have frequently tried the latter compound, but have never seen from it results which could not be better obtained from other bromides, or from camphor separately. Testa found zinc bromide specially good in hystero-epilepsy, and others have shown that it exerts the effects of the metal as well. Some prefer to give it as oxide separately in pill, at the same time as alkaline bromides in mixture. In the same form of malady, C. Paul advocates the bromide of strontium, and Féré found it lessen the relapses and nervous crises occurring under the potassium salt. The former has been specially recommended by several writers, *e.g.*, by Dr. Byrom Bramwell in 1888, and Dr. Roche has recorded a few

cases of remarkable improvement under its use after failure of other compounds given without it (Lancet, i., 1896). The dose may be somewhat larger, 20 grains increasing to 60, night and morning, and sometimes thrice daily, the diet being mainly milk and vegetables. Dr. Cullinan has published two similar cases recovering under $\frac{1}{2}$ or 1 dr. doses four times daily, borax being given at the same time; he noticed less mental hebetude from it (*ib.*, ii., 1899). Dr. J. G. Smith has carefully tabulated twelve chronic cases at Hanwell, comparing the effects of the strontium and the potassium salt, and found sometimes the former controlled the attacks better—in four cases the effect seemed equal, in three the potassium bromide acted better and more lastingly with smaller doses (*ib.*). Bromopin has acted well (Hesse, *loc. cit.*), and I have tried it in several cases where it controlled the attacks better and with much less depression, anæmia, or acne, than other bromides. Beigel recorded good results from bromides, morphine being administered hypodermically at the same time (Med. Times, i., 1869), but morphine, when given internally for any length of time, acts injuriously, and when subcutaneously administered for a similar time is still more detrimental. I am satisfied, from careful and long-continued observation, that opium does not, in any form or combination, cure epilepsy, but when convulsive attacks occur as complications of passing mental disease it is sometimes helpful, either alone or combined with bromides, in temporarily allaying the excitement and convulsions, and procuring sleep, but its effects are transient.

The proportion of *cures* obtained by bromides or their combinations—meaning a cessation of convulsive attacks for from six months to four years or upwards, according to the period that cases remained under observation—has been stated at about *one half* for adults and one quarter for children (Voisin, Legrand du Saulle), and even if *absolute* cure be not obtained quite in such proportion, it is so sufficiently often to prove its possibility. Probably, however, in the majority of cases, freedom from attack will be contingent upon more or less continued use of the remedy. In cases that are satisfactory, we see nothing of an effect sometimes mentioned as an objection to the use of bromides, *viz.*, a greater violence of the attacks as they become less frequent. It is true that this occurs sometimes during the natural course of

the malady, but it cannot be directly connected with the medicine; on the contrary, the drug as a rule diminishes the severity as well as the frequency of the convulsion.

In cases of fits due to organic lesion of the brain, and in Jacksonian epilepsy, the power of bromides in lessening their severity is very marked. At first the fit may affect the whole body, and be accompanied with loss of consciousness; after the use of bromides, although the fits may not entirely disappear, they become limited, often to one limb, or part of a limb; each fit lasts a shorter time, and there may be no loss of consciousness. For such conditions the best results are obtained by giving iodide and bromide simultaneously, the iodide possibly relieving the syphilitic or inflammatory lesion to which the fits are due.

Binz has suggested that not only the physiological, but also the therapeutical effect of the bromide of potassium is due to the latter agent (potassium) improving the blood-condition (Pract., 1874), and Saunders states that the *chloride* of potassium has answered equally well in his hands (Centralblatt f. Med., 1868); but whilst we agree that some of the depressant effects of bromide of potassium on the circulation might be explained by the known action of potash, its effects on the nervous system cannot be so, and the result of Sequin's observations showed that the use of chloride of potassium *increased* the attacks in cases which bromide *relieved* in the proportion of 80 per cent. (Med. Times, i., 1878). The nitrate and bicarbonate of potassium have also been proved useless (Anstie, Pract., 1874).

In the Gulstonian Lectures for 1880, Sir W. Gowers says that when small doses of the bromide are given to ward off regularly recurring attacks, they should be taken only a short time—two or three hours—before the fits are expected; that they will fail if taken at longer intervals before; larger doses may, however, be taken then. In many cases he has noticed a cumulative effect of the drug, but in others a tolerance of, or indifference to it, is attained, and an increase of the dose becomes necessary to obtain the customary result. To *control* the fits the bromide must be given frequently, but not in larger doses than a drachm or a drachm and a half in the day; but for the *cure* of the disease he considers it necessary to keep the patient for a time under the full influence of the drug, by giving a large dose every two or three

days—as much as can be well borne. Gowers has thus given as much as an ounce at a time, but adds the caution not to begin with a larger dose than half that quantity. He considers that only in this way can the “stability of the resistance of the nerve-cells” be re-established. He advises continuous treatment for two years after the last attack, and then in diminishing doses for another year. The drugs that he has found most useful in combination with bromide are digitalis (where there is inter-current cardiac disturbance, or in nocturnal epilepsy), belladonna, cannabis indica (when there is persistent headache between the attacks), and iron.

Convulsions.—In the wide range of convulsive and spasmodic disorders, *outside* that which we distinguish as epilepsy, bromides are very efficacious. In the convulsions occurring during *pregnancy*, especially from reflex irritation at the time of parturition, they are more distinctly indicated than in the albuminuric form, but I have seen them also relieve the latter. Peaslee thought them valuable only during the threatening stage when the urine is scanty, and certainly, the earlier the patients are brought under their influence, the more satisfactory the result. In *uræmic* and *toxic convulsions*, *e.g.*, in plumbism, some observers have objected to the use of bromides, but they have been found generally of some assistance in lessening the paroxysm; eliminant and other remedies should be conjoined with them. The dose in such cases should be large, $\frac{1}{2}$ dr. every hour or two. When swallowing is impossible, they act well given in enemata (Gimbert and others, *Med. Times*, i., 1872, and i., 1874).

Dentition.—In the restlessness and nerve-irritation or convulsions sometimes attendant on dentition, bromides are exceedingly useful, “so that the gum-lancet is scarcely ever needed.” The convulsions even of meningitis I have frequently seen arrested by the bromides.

Tetanus.—Strychnine Poisoning.—Since bromides lessen spinal congestion, and diminish reflex irritability, they are, at least, valuable adjuncts in these conditions. In a collection of four hundred and fifteen cases of tetanus by Dr. Yandell, bromide does not seem to have been used once (*Brain*, Oct., 1878), but Dr. H. C. Wood has tabulated eighteen cases of tetanus thus treated, and of these only two died; in one of them, large doses

of belladonna confused the result. In most of the successful cases, chloral or morphine was given at bedtime.

Saison found with animals that hypodermic injections of strychnine distinctly modified the action of bromide, and *vice versâ*; and there are many instances in which a fatal result from poisoning was, in all probability, prevented by bromide treatment. Thus, Dr. Gillespie records a case in which nearly 3 gr. of the alkaloid were taken, and very serious symptoms developed; but recovery took place under the influence of an ounce of bromide given in divided doses—no vomiting occurred (Amer. Journ., Oct., 1870). In Dr. Hewlet's case, more than 4 gr. of strychnine was taken, and although vomiting had occurred and opium been given, severe convulsions had set in; 90 gr. of bromide were administered, at first every half-hour, and afterwards 60 gr. every hour, and twenty-six hours after the first dose the patient could walk (Brit. For. Rev., July, 1871). Another case of recovery after a 3 gr. dose of the poison, and similar treatment, is given by Dr. Bard (Philad. Med. Times, June, 1871—Record, 1879; see also Lancet, ii., 1890).

Migraine, Congestive Headache, etc.—If given in the prodromal stage of an attack of migraine, the bromides often succeed in preventing its development, and especially when the pain in the head and the nervous disturbance *précède*, or are more prominent than the nausea or gastric disorder (Yandell, Latham). Five grains every hour or half-hour may be given, but if an attack *has already set in*, a full dose of 20 to 30 gr. is better, and if this produces sleep, the patient usually wakes free from headache. After the paroxysm has *fully* set in, the remedy does not seem to control it (Med. Times, i., 1875).

In ordinary congestive headache, with flushed face, and intolerance of light and noise, and in congestive neuralgia generally, the bromides are serviceable; also in the headache occurring in delicate children from even moderate application to study. Dr. A. Boggs, after personal experience, says that the best result from the use of bromides is obtained from a mixture of the three salts of potassium, sodium and ammonium. He recommends, especially in congestive headache, a mixture containing potassium bromide 4 dr., sodium and ammonium bromides, 2 dr. each, and water 12 oz.; a tablespoonful every two, four, or six hours, as the case demands; digitalis and arsenic may be added later. Professor

Charcot prescribes a similar combination in cases of epilepsy (*cf.* Lancet, ii., 1884). Dr. Day recommends their use with iodides for children who suffer from constant headache and debility (Lancet, i., 1875); but I have been disappointed with this combination under such circumstances, and find cod-liver oil and fresh air better remedies.

Chorea.—I have seen a few patients recover rapidly under treatment by bromide, but the majority are too anæmic or asthenic to bear it well. Dr. Ramskill tried fully the potassium salt, “and with strong prejudice in its favour,” but without satisfactory result. Camphor bromide is said to have acted better (B. M. J., i., 1877), but has not done so in my experience: still there are cases, especially in adults, when these remedies are useful adjuvants to iron and arsenic.

Hysteria.—In ordinary cases of hysteria, bromides alone do not give the relief that might be expected. The convulsive epileptiform seizures which sometimes occur may be controlled by them when the patients are fairly strong, but mere emotional disturbance and nervous debility are better treated by other remedies. The malady is essentially connected with enfeebled nervous power. Gubler indeed compares its paroxysms to convulsions after hæmorrhage, and in such cases bromides are not really curative. In combination, *e.g.*, with iron, valerian or camphor they may be of more service, and hydrobromic acid acts well with quinine or strychnine.

Uterine Irritation.—If hysterical symptoms be definitely connected with ovarian irritation or uterine congestion, the bromides are more distinctly indicated; they often relieve the pain of congestive dysmenorrhœa.

In the distressing condition of unrest, undue apprehension and depression which often occurs at the climacteric period, they may prove of the greatest service, quieting the restlessness, and relieving the sense of fulness in the head, and flushing of the face. Dr. Ringer found them to exert a favourable influence over the apprehensive and desponding thoughts which arise sometimes in the later periods of pregnancy (Lancet, i., 1869), and they have relieved even the sensations and symptoms of a “spurious pregnancy” occurring at the climacteric (Simpson, Med. Times, ii., 1859).

Menorrhagia.—Leucorrhœa.—Bromides often act very well in relieving both of these discharges, but especially the former when dependent on congestion; and a good illustration, in which the attendant acne was also cured, is recorded by Dr. Arthur Jamieson: he notes that a bromide rash was distinguishable from the original one (Practitioner, i., 1889).

Laryngismus Stridulus.—The bromides, but especially the bromide of ammonium, will be found very useful in relieving the laryngeal spasm of this disease; but its usual connection with rachitis must not be overlooked, and tonic treatment, good hygiene, and improved nutrition must be prescribed in order to obtain a satisfactory result.

Pertussis.—Dr. Gibb was one of the first to ascertain the value of bromides in this disorder, and he found the ammonium salt to act best; it quickly relieves the whoop, *i.e.*, the laryngeal spasm. Dr. G. Harley also early recorded satisfactory cases (Lancet, i. and ii., 1863). I have often verified this use of the bromides, especially in early stages. I order for children 3 to 5 gr. every two to four hours, as a rule not giving more than 20 gr. in the day, because of the depression induced in weakly subjects: I often combine belladonna, and sometimes chloral, with the treatment. Dr. Ringer reports them as useful only in simple uncomplicated cases, but neither dentition nor a pyrexial state need prevent their use if the spasm continue; they may be fairly presumed to lessen congestion in the medulla as well as in the mucous membrane of the fauces, and to diminish reflex excitability.

If catarrh be present, an expectorant may be added, and if bronchitis or pneumonia supervene, the spasm generally subsides for a time, and a different treatment is indicated. The convulsion of pertussis I have frequently seen relieved by bromide, but belladonna is much more serviceable.

Bromofom has been much commended by Stepp, Senator, and Schippers (B. M. J., Epit. ii., 1891). In several hundred cases between six months and seven years of age, the relief of spasm, vomiting, and hæmorrhage is said to have been quicker than under ordinary treatment, and the drug had no bad effects in doses of from 2 to 6 minims thrice daily. Only in two cases, when a large quantity was taken by accident, symptoms of collapse occurred. It seems to be effective only in some cases, others in which it

does not benefit are presumed to be due to a "mixed infection." It is important to dissolve the drug thoroughly in spirit and then to carefully emulsify, for in one case, at least, where only $\frac{1}{2}$ minim doses had been ordered, toxic symptoms followed the last dose left, in which more had accumulated (B. M. J., i., 1899; i., 1900). In another case $1\frac{1}{2}$ dr. were taken, but recovery was obtained after lavage, stimulation, etc. (*ib.*). My own experience with it has not been specially favourable.

Dysphagia.—There is a peculiar form of difficulty in swallowing liquids which I have seen only in children; they drink readily, but the fluid either returns at once from the mouth or partly chokes them, or they remain, with open mouth, gradually swallowing small quantities with continued muscular spasm. No definite cause can be assigned. The symptoms come on a few months after birth, and I have seen it mostly amongst the children of the poor. It may be relieved by bromide, and Dr. Ringer has remarked that a similar condition, when congenital, is much benefited by bromide of potassium.

The dysphagia of phthisis, connected with local irritation and inflammation, is also relieved by the salt, which should be swallowed slowly and well diluted with mucilage.

Colic.—In cases of cramping pain in the stomach or intestine, such as occurs more frequently in children, and is independent of diarrhoea, but connected with irregular muscular contraction, the bromides usually relieve.

Spasm of Rectum and Bladder.—In cases of tenesmus, whether of the bladder or rectum, bromides will often be found useful. Hammond recommends bromide of camphor (B. M. J., i., 1877), and $\frac{1}{2}$ dr. doses of bromide of potassium have given relief to a severe case of rectal spasm, when opium, belladonna, and instrumental interference had all failed (Lancet, ii., 1873).

Enuresis.—In the simple enuresis of children, bromides may usually be relied upon. The good derived from them is probably due to "increasing the stability of resistance of the cells in the lower part of the spinal cord" (Gowers).

Spasmodic Asthma.—There are certain cases in which very striking results may be obtained from the bromides: *e.g.*, a man, aged thirty, subject to attacks since infancy, suffered about once in the week from evening till two or three o'clock the following

morning, but after a fortnight's treatment with full doses of bromide taken at night, he had no further attacks (Saison). As a rule, it will be found that this remedy does not act so well as an "antispasmodic" during the paroxysm, but is better if given during the interval, apparently by exerting a sedative influence on the central nervous system.

Dr. Begbie found it very successful in two cases (Edin. Med. Jour., 1866), and G. Sée reported that though the catarrhal element in the malady was not modified, the paroxysms were delayed, and the dyspnœa lessened or quite controlled (Bulletin, 1865). I can recommend the bromide in chronic cases of asthma, and especially when there is eccentric irritation, as of the pelvic organs; it is sometimes well combined with iodide. The fumes of ammonium bromide are also said to relieve asthma (Lancet, i., 1890).

Angina Pectoris.—Palpitation.—The bromide is sometimes of service in severe breast-pang. Thus, Papillaud relieved paroxysmal attacks by the use of $\frac{1}{2}$ to 2 dr. doses continued "at intervals" for two or three months. In nervous palpitation it is often a very good remedy, and I have known it especially relieve gouty patients. Berger found bromide of camphor answer well, and bromide of iron relieves irregular cardiac action connected with anæmia and debility.

Undue Reflex Action, Vomiting, etc.—In a number of cases, somewhat dissimilar in symptoms, but connected with exaggerated reflex action, whether spasmodic in character or exhibiting altered function or secretion, the bromides prove useful. In reflex vomiting, as that of pregnancy, or in sea-sickness, especially if the administration be commenced two or three days prior to embarking, and sometimes in cerebral vomiting, they give relief. Five to ten grain doses, if retained, are often sufficient, but in obstinate cases connected with pregnancy $\frac{1}{2}$ to 2 dr. doses have been successfully given by injection (Lancet, i., 1874). Laborde has seen it useful in the vomiting of various gastrointestinal disorders.

Diarrhœa.—Dyspepsia.—When this is reflex in character, as it often is during dentition, or when "emotional," or associated with a congested relaxed state of the intestinal mucous membrane, bromides may prove the best remedies. The bromide of strontium has been found serviceable in gastralgia, flatulent dyspepsia, and

pyrosis. M. Sée found it prevent fermentation and formation of gas in the intestines, in doses of 10 to 20 gr. with or after meals (Bull. de Thérap., 1891). It may be combined with pepsin.

Diabetes.—Dr. Austin Flint reported, many years ago, three cases of saccharine diabetes treated by doses of 15 to 20 gr. of potassium bromide thrice daily, with marked improvement in all symptoms (Amer. Pract., 1870); and since that date the remedy has been used alone and in various combinations, and frequently with advantage.

Spermatorrhœa, etc.—In irritation of the male genitals in plethoric subjects, with undue erections and excessive seminal losses, the bromides are often highly useful. They have a local anæsthetic effect when applied to the urethra, and when taken internally their value is evident both when sexual excitement is connected with local irritation and congestion, as hæmorrhoids, ascarides, etc., and when there is mental or central causation. They tend to lessen, also, spinal congestion and reflex irritation. When there is marked debility with anæmia, or when spermatorrhœa is unaccompanied by erections or sensations, bromides alone are not the best remedies, but iron may be well combined.

Cystitis.—Urethritis.—Saison has seen the bromides give great relief in these cases. They should be used both locally and internally.

Subjective Nervous Symptoms.—A number of anomalous symptoms, which may be placed under this heading, are relieved by bromides; for instance, “sudden numbness, coldness, deadness, or pricking sensations in one or more limbs; distressing, indefinite feelings in the epigastrium or abdomen; or sensations akin to rigor, with much anxiety and palpitation or ‘fluttering’ of the heart.” In such cases the local circulation may be interfered with, the pulse in one arm becoming irregular and faltering, whilst in the other it may remain unaltered, and the heart-beats continue normal.

Urticaria.—In this malady, which is connected with irregular action or paresis of vaso-motor nerves, the bromides are indicated. Thus, Dr. Andrews reports the cure of a chronic recurrent case under their use (Lancet, i., 1870).

Exophthalmic Goitre.—According to Dr. Brown (U.S.) and others the bromides have proved useful in this malady (Brit.

For. Rev., i., 1868), and I think benefit may usually be expected from them, especially when combined with quinine, or with iodides and iron.

Phthisis.—There are certain distressing phthisical symptoms which are amenable to the influence of bromides on vaso-motor nerves and reflex action. Thus, a hacking cough, or reflex vomiting, may be relieved; also the difficulty and pain in deglutition connected with pharyngeal irritation. Profuse sweating and even flux from the bowels may be controlled by the bromides—especially by bromide of calcium—though usually the anæmic and depressed condition may be met better by acids or mineral astringents.

Insomnia is but a symptom, and one produced by various and often opposite pathological conditions. We accordingly find that the different hypnotics cannot be used with equal success in all cases presenting this one symptom in common, and so while bromides are of most signal value in some conditions, they are useless or even harmful in others. This may be explained partly by varying conditions of the blood-supply, partly by difference in the states of nutrition of the nerve-cells. It is when there is *moderate cerebral hyperæmia*, such as probably exists after prolonged mental effort—whether associated with study, with excitement, or anxiety—and when unrest and sleeplessness are marked symptoms, that the bromides are far more soothing, and more curative than opium, and even if inflammatory action be present they may still be very serviceable, in conjunction with aconite, ice, or other remedies.

If there be much cerebral *anæmia* it may be even increased by the remedy, and I have seen, in debilitated hypochondriacs, and in some aged people, aggravation of the symptoms, with marked increase of the prostration. In some cases of senile insomnia, I have, however, found it very useful given with the last meal, in doses of 10 to 20 gr. or more dissolved in milk, tea, soup, beer, or cold water. In the sleeplessness of convalescence from acute disease and of dyspepsia, bromide is useful, combined in the latter case with dietetic and other special treatment. In pregnancy, where pain is suffered and prevents sleep, a combination of chloral and bromide—15 gr. of each—is especially useful. In weakly subjects, and especially in the insane or hypochondriacal, bromide

is best given in combination with *cannabis indica*. When insomnia is induced by severe pain, opium is the best remedy; but its effect is heightened, and its tendency to produce headache, faintness, or nausea lessened by bromide. Da Costa recommends the latter to be given in full doses half an hour before, and two hours after the opium.

To choose a suitable dose is of importance, but from 20 to 30 gr. usually suffices. The bromides can be pushed without fear, or, at most, with the fear only of bromism, which, if it supervene, will subside quickly on discontinuing the drug. Bromides are not only safe hypnotics, but the after effects are slight, as compared with those of opium.

Wolfe relates a case of insomnia with hypochondriasis and irritability from overanxiety, when 5 gr. proved useless, but $\frac{1}{2}$ dr. "acted like a charm." Behrend relates two very good illustrations of nervous excitement and anxiety, with loss of sleep, in which 25 gr., at first thrice daily, afterwards less often, proved quickly curative (*Lancet*, i., 1866; ii., 1864). In the sleeplessness and delirium of fevers, the bromides exert a favourable influence in procuring sleep, and they prove a valuable resource when opium is not admissible. The ammonium salt has been found less effective than that of potassium (*B. M. J.*, i., 1891).

I have sometimes found bromide of camphor, in 3 to 5 gr. doses, procure sleep for hysterical subjects, and Deboul recommends it in the unrest of cardiac disease, and of phthisis (*Brit. For. Review*, i., 1865). The solid capsule of Clin is liable to cause gastric irritation, and it is better given dissolved in milk.

Delirium Tremens.—For the excitement, wakefulness, fright, and tremor which follow the abuse of alcohol, and commonly precede a fully developed attack of delirium, large doses of bromide often prove of great use, either with or without opium. I have known them prevent the further development of the attack; in later stages they have not the same power, but bromides have acted well combined with chloral. To this statement I must, however, add a caution as to the use of full doses of the latter remedy in delirium tremens, for I am cognisant of more than one case of sudden death in all probability traceable to it.

Gubler has written specially on the value of bromides in alcoholic amaurosis.

Night-terrors. — “**Nightmare.**” — Children are liable to attacks of terror in the night, when they awake screaming, and are so deeply impressed by some imagination or dream that they are, at first, scarcely conscious. This condition is connected with a reflex irritation of the nervous system, and is much under the control of a night-dose of bromide. The nightmare of adults may also be relieved by it, though, in their case, the discontinuance of heavy suppers would often prevent the unpleasant dreams; aperients should not be neglected in such cases.

Mania. — The use of bromides in insane patients requires special study and care, because of their liability to be suddenly depressed, and the prostration I have sometimes seen well illustrates the clinical fact that an enfeebled, ill-nourished nervous system often contra-indicates these medicines, even if the general bodily health seems to be fair.

Dr. S. W. D. Williams records that of thirty-seven insane epileptics treated by bromides the fits were relieved in most, but great depression occurred in some of them without any relief to their attacks; $\frac{1}{2}$ dr. doses proved too large; catharsis was caused in two cases. Dr. T. Outterson Wood has also recorded instances amongst insane patients of “sudden development of severe prostration and despondency” (B. M. J., ii., 1871); vomiting and abdominal pain were also caused.

Dr. Clouston found that the bromides, if given alone, must be used in very large doses to subdue violent paroxysms. One female patient took 7 oz. in divided doses, but then suddenly lapsed into a condition of extreme “torpid depression,” not free from danger to life, and continuing many days. The same physician ascertained that a combination with cannabis indica gave, even in small doses, much better results than either remedy alone, $\frac{1}{2}$ dr. of each given together acting as a hypnotic better than 1 dr. of tincture of cannabis indica, or 2 dr. of bromide (Med.-Chir. Rev., ii., 1870 and 1871).

Dr. Macleod (Shanghai) has published several cases treated by “bromide sleep” induced by large doses, 2 to 4 drachms every two to four hours, and continuing for several days, interrupted only for draughts of milk. In *morphinomania* and also in the chloral and

cocaine habit, and even in alcoholism, the same treatment has proved effective (B. M. J., ii., 1897; i., 1899; i., 1900), but, of course, it involves risks.

Puerperal Mania.—In acute stages of excitement and delirium connected with the puerperal state, bromides act well and should always be given. They have, doubtless, an influence over the uterine and ovarian congestion of that state, and over reflex irritability, and many successful cases of its use are on record. Curgenven has found the potassium salt act quickly and well when given by the rectum. I have often given it with aconite, with much advantage.

Erotomania. — Nymphomania. — When these conditions occur in connection with a generally demented state, the bromides do not seem to relieve so much as might have been expected. Dr. Mackey, when in charge of a large asylum at the time bromides were first introduced, and were specially recommended in sexual cases, gave the potassium salt to many of the younger patients, especially youths addicted to masturbation, but generally with the result of inducing extreme and miserable depression, without controlling the symptoms. Dr. Williams also noted that in his thirty-seven insane cases the sexual system was not at all, or but slightly, affected. Even in subjects of average mental health, but addicted to onanism, the bromides, though they lessened the venereal appetite for a time, effected no cure in Dr. Bill's experience, and he concluded that they could lessen only *eccentric* sexual irritation (Amer. Journ., July, 1868). In this they certainly are highly valuable. In the few cases that I have seen approaching to nymphomania, benefit was derived from the bromides alone, but they act best when given in conjunction with baths, counter-irritation, and moral agencies. Dr. E. C. Clarke and Dr. Begbie have recorded very satisfactory results.

Cerebral Apoplexy.—There is reason to hope for advantage from the use of bromides in the symptoms of cerebral congestion which point to an apoplectic tendency. Dr. Bastian has remarked that, in such cases, when the heart-action is forcible and frequent, these remedies, conjoined with aconite, are very suitable, and I concur in this statement (Lancet, ii., 1874).

Spinal Congestion. — Cerebro-spinal Meningitis. — In spinal congestion of acute character, with pain, hyperæsthesia,

cramp, and spasm, the bromides have proved so far useful as to merit a fair trial. In true cerebro-spinal meningitis—though a very fatal disease under any treatment—I have seen great advantage from bromides, but like all depressant remedies they must be used with caution, for there is liability to sudden failure of the circulation from conditions of the disease itself.

In other forms of meningitis (traumatic or tubercular) they meet some indications (*cf.* Glas. Med. Journ., 1873).

Bronchocele.—Splenic and Glandular Enlargements.—The great value of bromides in nervous disorders has led us, perhaps, to think less of them as remedies in tubercular and glandular enlargements, but they are often useful in such conditions. Sir Samuel Wilks recorded their good effect in bronchocele (*Med. Times*, ii., 1861), and I have used them frequently and successfully in glandular swellings connected with tuberculosis. They have been recommended by others in combination with liquor potassæ (*Lancet*, i., 1860). The bromo-iodine waters of Kreuznach and Woodhall Spa are also good forms for their administration.

Dr. Robert Williams found the bromide of potassium extremely useful in reducing enlargement of the spleen due to malaria, and, in an appendix to his work on Morbid Poisons, gives several striking instances of its value, when other more usual methods had failed.

Sir Spencer Wells confirmed the observations of Dr. Williams, and, amongst other cases, recorded that of a child, aged eight, extremely emaciated, suffering from hectic and an enormously large spleen, the lower edge of which extended to the pubes. The case seemed beyond the power of medicine, but under the influence of 3 gr. of bromide thrice daily, some diminution was produced within a week; under 5 gr. this continued, until at the end of a few weeks the viscus was above the umbilicus, and the child convalescent. The case was either connected with ague or with blood poisoning and is very remarkable. I have used the drug in similar cases, in larger doses, and with satisfaction. Claude Bernard has recorded equally good results, but with doses of 20 to 40 gr. daily (*Bulletin*, 1874).

Fibroid Tumours.—The power which bromides possess of stimulating absorption led to their use in cases of uterine fibroid, and Simpson recorded successful results (*Med. Times*, ii., 1859), as did also Graily Hewitt (*Med. Times*, i., 1861): though recently

many surgeons have undervalued medical treatment as useless compared with surgical (B. M. J., ii., 1900 ; i., 1901).

The Kreuznach waters, which contain bromides and iodides, have long enjoyed a special reputation in such cases ; but, if we are to judge by a discussion which took place some years ago, many eminent authorities in London have seen little or no advantage from them (Med. Times, i., 1857). My own experience, however, and personal observations made at Kreuznach, have satisfied me that these waters often diminish the congestion and the fibroid growths, and dense infiltrated deposits around, and have given much relief to the patient, although their good effects probably are not *wholly* due to their containing bromides and iodides.

Ovarian Tumour.—Upon several of my patients with unilocular ovarian cysts, the same waters have acted so favourably that, in cases where an operation is not permitted, I now always recommend one to three courses of them. Bromides given in 5 to 20 gr. doses two or three times daily, and continued for months, frequently diminish the size of the cyst, and improve the general health. The dose should be varied from time to time, according to circumstances.

Absorptive Effects of Bromides.—There are other growths and deposits in which these effects have been utilised by different observers. Dr. Wilks observed benefit from the bromide of potassium in cases of cephalalgia dependent on thickened membrane or thickened bone (Lancet, i., 1870) ; Dr. Brown, in acute and chronic inflammation of the testes and chronic inflammatory enlargements (Brit. For. Rev., i., 1868) ; and Dr. Bird states from ample experience in Australia, where hydatids are common, that the continued administration of bromides has the power of destroying the parasites, and causing absorption of the cysts (Med. Times, ii., 1873).

PREPARATIONS AND DOSE.—*Potassii bromidum* : dose, 5 to 30 gr. and upwards. *Ammonii bromidum* : dose, 5 to 30 gr. and upwards. *Sodii bromidum* : dose, 5 to 30 gr. and upwards. *Acidum hydrobromicum dilutum* : dose, 15 to 60 min. The following and others are non-official (v. p. 127) : *Lithii bromidum* : dose, 5 to 15 gr. *Strontii bromidum*, *Calcii bromidum* : dose, 10 to 30 gr. *Camphora monobromata* : dose, 3 to 10 gr.

Concerning the different bromides, we may here briefly state that the *potassium salt* is in most common use, but contains the

least bromide of the alkaline salts, and is more depressing to the circulation. The *sodium salt* I consider rather more powerful as a bromide, though all observers are not agreed on this point. It is less depressing, and is more easily assimilated (Clymer, Med. Times, i., 1872). The *ammonium salt* possesses some of the stimulant characters of its base, which is liberated by decomposition. Its action is said to be more rapid, but also more evanescent (Begbie). The *lithium salt* has been said to relieve some epileptics better, and in smaller doses than the potassium salt, and to act better as a hypnotic (Gibb, 1864; Weir Mitchell, Amer. Journ., ii., 1870). The *calcium salt* is said to be more active than that of potassium, 22 gr. of the former causing sleep when the latter failed (Hammond). The *iron bromide* is given in doses of 3 to 10 gr., or in Syrup (B. P. C.): dose, $\frac{1}{2}$ to 1 dr. *Zinc bromide* has been given in the same dose. *Bromide of gold*: dose, $\frac{1}{60}$ to $\frac{1}{5}$ gr. The *compound with camphor* (monobromated camphor) reduces heart-action and lowers respiration and temperature like the alkaline bromides; it is efficient as a sedative in smaller doses—3 to 6 gr. I have found the *compounds with morphine and quinine* useful. The *strontium salt* is specially suited for dyspeptic and depressed cases. *Bromoform*: dose, 1 to 6 min. (with alcohol or ether), (v. p. 146), thrice daily, up to six or seven years; 7 or 8 min. for adults. *Bromal hydrate* has been given in 3 gr. doses for sleep, but is too irritant to the stomach. *Bromipin*: dose, 10 to 60 min. (v. p. 127).

CHLORUM—CHLORINE, Cl=35·5 (35·19).

Not Official.

Chlorine, discovered by Scheele in 1774, is a gas of sp. gr. 2·450, greenish in colour (whence its name), volatile and irrespirable, and when incautiously inhaled producing injurious irritant effects. It has a peculiar odour, is very soluble in cold, less so in hot, water, bleaches all vegetable colours, and is a powerful disinfectant; under a pressure of six atmospheres at 32° F. the gas becomes a yellow liquid of sp. gr. 1·33. It does not occur free in nature, but is found combined with metals forming chlorides, of which sodium chloride is the most common.

LIQUOR CHLORI—SOLUTION OF CHLORINE (IN WATER).

CHARACTERS.—The liquor chlori is slightly greenish in colour, smelling strongly of the gas, of which it contains about 66 per cent., and possessing its bleaching and disinfectant properties; its sp. gr. is 1·003, but it is very unstable, and readily loses strength. Under the influence of light, chlorine slowly decomposes water with production of hydrochloric acid and oxygen, and the solution then loses its characteristic properties. Hence the advantage of preparing it fresh for use, and the necessity of employing stoppered dark-coloured bottles for preserving it.

The *hypochlorites of calcium, sodium and potassium* owe their special properties to the presence of chlorine, and, as commonly met with, are mixtures of hypochlorites and chlorides, known popularly as “chloride of lime” (bleaching powder), “chloride of soda.” A solution of the soda salt is known as “Eau de Labarague,” from the chemist who popularised it, and a solution of the potash salt is the “Eau de Javel” of Parisian laundries. Under the influence of feeble acids, *e.g.*, the carbonic acid of the atmosphere, these salts evolve free chlorine until wholly decomposed.

The main chemical character of chlorine is its energetic affinity for hydrogen, which element it will abstract from its aqueous, gaseous, and organic combinations. In contact with organic substances it is inactive if they are quite dry, but if moisture be present nascent oxygen is liberated from the water under the action of chlorine, and destroys or oxidises the organic compound. A solution destroys the lower forms of organic life, and the gas brought into contact with sulphuretted hydrogen decomposes it, hydrochloric acid being formed, and sulphur precipitated. Hence chlorine is a good disinfectant and deodorant, but limited in its power, for after it has once caused the oxidation of organic matter, or become changed into hydrochloric acid, its disinfectant qualities are almost lost; its strongly corrosive action also limits its use.

ABSORPTION AND ELIMINATION.—Chlorine gas may be absorbed through the lungs, as proved by finding its odour in the brain, after death from its inhalation (Cameron). A dilute solution when swallowed combines with albumin and with alkaline salts, either in the stomach or the blood, to form chlorides, and as such passes out, mainly by the kidneys. Husemann suggests that hydrochloric acid rather than chlorides may be formed from small doses.

The hypochlorites, decomposed in part by the gastric acid, give off free chlorine, and then passing into the circulation are excreted as chlorides of potassium and sodium. Kletzinsky ascertained this, and taking himself for a fortnight a daily dose of 60 gr. of “chloride of soda” (hypochlorite), found an increase of 30 to 40

gr. of sodium chloride in the urine (Canstatt-Jahrb., 1851, Bd. i.). Some amount of free chlorine would also seem to pass in that secretion, for after absorption of the gas (in a chlorine bath) Wallace found the urine to possess bleaching properties, though neutral to litmus paper.

PHYSIOLOGICAL ACTION.—*External.*—Chlorine acts as an irritant, causing, when applied in vapour or strong solution to the skin, a sense of prickling, with perspiration, congestion, and sometimes papular, or vesicular eruptions. Herscheimer records in four men working in chlorine vapour a chlorine rash resembling bromic acne, but this is unusual (Münch. Med. Woch., 1899). Chlorine water long applied causes a fatty degeneration and peeling off of the upper layers of the cuticle (Bryk). On denuded surfaces or mucous membranes the irritant effect is still more marked—the liquor sodæ chlorinatæ, for instance, if applied too strong to the throat or vagina, causes much discomfort. The vapour, if much diluted with air, may be breathed without other symptoms than a sense of heat and subsequent increase of expectoration; but if breathed in full strength, it acts as a violent irritant to the respiratory tract, causing spasm of the glottis, convulsive cough, and a sense of severe constriction and suffocation. Death may follow from inhaling an atmosphere of only 1 per cent. of chlorine, not from convulsive closure of the glottis, as formerly thought, but from the intense irritation set up in the air passages, as shown during life by the pain, cough, bloody sputa, etc., and after death by the secretion in the finer bronchi, hepatisation of the lungs, and rarely, a membranous exudation in the trachea.

Some degree of *toleration* of chlorine may be established, for in bleaching works the men can remain many hours where a stranger is at once attacked with coughing and irritation.

PHYSIOLOGICAL ACTION.—*Internal.*—The general systemic action of chlorine is that of a *stimulant*, more or less in degree, according to the quantity absorbed; and there is no sufficient evidence of the calmative properties described by Albers.

Circulatory System.—Brought into contact with blood-serum, it coagulates the albumin, loses its characteristic odour, and forms, after a time, hydrochloric acid. In animals dying

from inhalation of chlorine, the blood becomes dark red, thick, and finely granular, from a similar coagulation of albumin (Eulenberg). A solution injected into the jugular vein destroys life with symptoms of asphyxia, and the blood then also is found dark red, but fluid (Nysten).

In man, normal circulation and respiration are quickened under the moderate influence of chlorine. Husemann, however, states that in typhus fever the pulse and temperature become lower under it, and he connects this effect with conversion of the remedy into hydrochloric acid.

Digestive System.—The same observer also traces to a change into acid an increase of appetite and digestive power, but an excessive dose deranges the stomach. Even weak solutions stop diastasic and peptic action outside the body, but not apparently when mixed with food on the stomach. Workmen exposed to the fumes of the gas suffer from acid dyspepsia and various symptoms traceable to gastric irritation; it is not likely that any change in the blood would occur from continuous exposure to the dilute gas, but it is possible that some local solution of gastric epithelium may follow the constant contact of hydrochloric acid formed and swallowed in the buccal secretions.

Glandular System.—Nutrition.—Chlorine has been credited with a stimulant action upon the liver and kidney. Kletzinsky asserts that the excretion of urea is increased under its use, and Gubler has observed emaciation, implying increased tissue-change. Husemann merely remarks that its power of stimulating the hepatic and renal functions “requires confirmation.” The fæces are said by some observers to become light-coloured under its use, suggesting an alteration in or lessened secretion of, the bile.

SYNERGISTS.—Antiseptics and deodorants.

ANTIDOTES AND INCOMPATIBLES.—In *gaseous* poisoning by chlorine the chemical antidotes are—Sulphuretted hydrogen, which forms hydrochloric acid (itself, however, corrosive to the bronchi); ammonia, very dilute, which forms a chloride of ammonium; and solutions of anilin (Husemann), which also coagulate albumin and are caustic. These are not practicable where human life is concerned: then the best remedy available would be inhalation of hot-water vapour.

Poisoning by the *solution* is best treated by albumin or milk

with magnesia. Kastner says alcohol and sugar are useful. For medicinal purposes, prussic acid and coloured vegetable preparations should not be prescribed with it.

THERAPEUTICAL ACTION.—*External.*—**Aphthæ.**—**Angina.**—As a local detergent and disinfectant, chlorine solution is serviceable. In cases of aphthous stomatitis I have known it quickly relieve when borax has failed.

In ulceration of the fauces, whether scarlatinal, septic, or syphilitic, a gargle containing $\frac{1}{2}$ dr. of liquor chlori in 6 oz. of water is one of the best for removing unhealthy discharges and sloughs, or a more efficient gargle may be made by putting sodium or potassium chlorate, 10 gr., with hydrochloric acid, 30 min. in a pint bottle, and when this is filled with the gas, cork for two minutes and gradually fill the bottle with water, shaking it at intervals to promote absorption of the gas. In salivation also it is useful.

Wounds.—**Chancre.**—A lotion containing chlorinated soda or liquor chlori, 1 part in 12 of water, is a good dressing for unhealthy suppurating wounds, and for chancres; or a poultice with chlorinated soda may be used.

Purulent and Fœtid Discharges.—An injection prepared with the chlorine solutions (1 part in 12) is effective in cases of offensive lochia after delivery, during puerperal peritonitis, etc. I have found it act better than potassium permanganate, but it produces some dryness, smarting, and irritation, if used too strong. Mr. Startin has drawn attention to the value of a chlorine lotion for similar conditions, lupus, etc. (*Lancet*, i., 1897), and 4 min. of a 4 per cent. solution, injected into the uterus, seem to have aborted threatened suppuration (*ib.*, ii., 1895).

If an injection be required in **Chronic Empyema**, one with chlorine is suitable, and freer from risk than some other remedies. In **Gonorrhœa** weak injections of a solution of chlorinated lime have proved curative.

As a *disinfectant* for the hands after dissections or post-mortem examinations, liquor chlori is efficient. This was proved on a large scale some years ago at the Vienna Maternity Hospital, when the students were accustomed to pass from the necropsies to the bedside. At one time the mortality amounted to thirty per month, but after the introduction of a chlorine wash for the hands, to be

used before and after every *post-mortem* examination, the mortality fell to about seven per month, the ordinary average (Med.-Chir. Trans., vol. xxxii.).

As an aerial disinfectant, the value of chlorine has been variously estimated. When cholera appeared in 1830 and 1831, chlorine-fumigation was officially ordered for clothes, wool, and other imports, but there was no satisfactory proof of its efficacy. The Board of Health Reports of that period, with the evidence of Gregory, Tweedie, and others, rather negative its value in limiting the spread of fever; and Bousquet reported that chlorine would not prevent the activity of vaccine virus (Lancet, ii., 1831).¹ On the other hand, Schoenlein and Eisenmann maintained its value in scarlet fever (*cf.* Lancet, i., 1867-69).

The general opinion of the profession, and the results of experiment, are against the possibility of controlling infection by a chlorinated atmosphere dilute enough to be respirable; it must be considered doubtful whether emanations from vessels containing chlorinated lime or from sheets saturated with it, really exert a remedial effect, though as a measure of precaution they may be worth using. In an empty closed chamber, the gas, if in sufficient quantity, is, no doubt, effective, for it has been proved fatal to bacteria, as also is a fresh solution of it. A vessel, containing common salt and binoxide of manganese, of each 250 grammes, water 500 grammes, and sulphuric acid 700 grammes, when placed on a high shelf and warmed, gives off chlorine gas in sufficient amount to disinfect 1000 cubic feet of space, and being heavier than air will diffuse through the room from above. Bleaching powder (chlorinated lime) is largely used as a deodorant and disinfectant. Saucerfuls of it may be placed in sick rooms; drains and infectious discharges, such as typhoid stools, can be disinfected by its means. Its solution is used to disinfect sheets, bedding, and clothing, and may be applied as just described in the case of chlorine water, to disinfect wounds and ulcers of all kinds, which have a foetid discharge. It is also a parasiticide, and may be used

¹ Dr. Baxter, however, proved that chlorine, added in quantity sufficient to render the lymph acid, abolishes its infective power, and in the same series of experiments found that chlorine, in the proportion of .078 per cent. or more, is equally antidotal to the virus of infective inflammation (Report to Local Gov. Board, new series, No. vi.).

for ringworm and scabies, whilst chlorine water is sometimes useful in relieving the itching of chronic skin diseases.

Phthisis.—The literature of forty years ago contains many cases of phthisis treated apparently with benefit, both in France and this country, by inhalation of chlorine. Elliotson recorded advantage from it, and I remember Sir James Simpson speaking well of the method, and pointing out that bleachers did not usually get phthisis, and that the air of bleaching works was found to cure cough. Further experience has not corroborated the expectations formed, although in cases of offensive and copious expectoration some benefit may be derived from chlorine inhalation. It is apt, however, to do harm by causing irritation.

In **Bronchiectasis** and **Gangrene of Lung**, chlorine-inhalations may certainly give much relief by their stimulant and disinfectant power.

THERAPEUTICAL ACTION.—*Internal.*—**Chronic Hepatic Congestion, etc.**—On the hypothesis that chlorine stimulates the biliary flow, liquor chlori has been given internally in hepatic congestion, and vapour baths containing chlorine sometimes do good. It is one element, at least, in the benefit often given by nitro-hydrochloric acid, internally or in bath, and an albumin compound—chloralbacid—has proved useful in gastric catarrh, atonic dyspepsia, and as a palliative in carcinoma: it supplies deficient acid and lessens fermentation (Munch. Med. Woch., 1899).

Fevers.—In pyæmia, scarlatina and other infective diseases the liquor chlori has been recommended; but as it probably circulates in the form of chlorides its effect as an internal germicide has been doubted. Watson, Murchison and more lately Burney Yeo have, however, held free chlorine to be one of the best antiseptics in such cases, and a formula recommended by the last named for typhoid fever is good and has been widely adopted: 30 gr. of powdered potassium chlorate and 60 min. of strong hydrochloric acid are placed in a 12 oz. bottle which is corked and shaken till it becomes filled with the gas, water is then gradually added with shaking so as to dissolve and not to expel the gas (as described above for a gargle), 24 to 36 gr. of quinine and 1 oz. syrup of orange peel are added: 1 oz. is a dose.

PREPARATIONS AND DOSE.—*Liquor chlori* (not off.): dose, 10 to 30 min. freely diluted. *Calx chlorinata*, chlorinated lime (bleaching powder). *Liquor calcis chlorinatae* (1 of chlorinated lime in 10 of water = 3 per cent. chlorine when fresh). *Liquor sodæ chlorinatae* $2\frac{1}{2}$ per cent. chlorine: dose, 10 to 20 min. *Chloralum* (not off.) is a disinfectant prepared by double decomposition of sulphate of aluminium and chloride of barium. *Chlor-albacid* (albumin compound): dose, 15 to 50 gr.

AQUA—WATER ($H_2O = 18$).

In the British Pharmacopœia “aqua” means pure, natural water containing a minute quantity of salts in solution, but free from odour, taste, or visible impurity. “Aqua destillata,” distilled water, is also official, and is water freed from saline constituents by distillation.

ABSORPTION AND ELIMINATION.—Moderate quantities of water taken by the mouth are soon absorbed, but not always at the same rate. When the body already contains a normal amount, an extra quantity is less readily taken up, but if the system has been temporarily drained by excessive diuresis, perspiration, or hæmorrhage, absorption goes on quickly. The condition of the intestinal canal, as regards emptiness or fulness, is also a factor. According to Robert Hutchison (Food and Dietetics, 1900) water is not absorbed by the mucous membrane of the stomach, but when swallowed begins to flow out of it at once in gushes—more quickly if hot; it starts gastric movements, “unlocks the pylorus,” and begins to be absorbed in the small intestine, mainly by the capillaries of the villi, not by the lacteals; absorption is most active at the lower end of the ileum, and being continuous through the large intestine the fæces become more solid: the fluid taken passes at first to lymph spaces in the tissues and is readily eliminated, so that the blood stream is not diluted or altered to an extent corresponding to the amount that is drunk (Schäfer, Physiology, vol. i.). The average fluid contained in a daily ration of food is reckoned at about 2,500 c.c.; the excretion is rather more, some being formed in the body by oxidation of hydrogen.

Elimination of water takes place by the kidneys, skin, lungs and intestine. In the kidney it is excreted by the glomeruli of the cortex, and by the epithelium lining the tubules. On an

average the skin eliminates only about two-thirds of the amount excreted by the kidneys, but the proportion depends largely on the relative activity of the renal and cutaneous circulation for the time being. Water therefore acts as a diuretic and diaphoretic: it augments the functional activity of the kidneys and carries off a proportionately increased amount of urea, urates, phosphates and other salts. If the extra quantity of water taken be within moderate limits, the increased elimination is accompanied, or soon followed, by increased absorption. In this way the general metabolism is stimulated, and an excess of water in the dietary leads to increased disintegration of the nitrogenous tissues.

The question whether water can be absorbed through the unbroken skin has been much discussed: the observation that weight may be gained by immersion in a bath is liable to error from the presence of cracks or fissures in the cutaneous surface; as a rule the natural sebum would prevent transudation of water from without, unless on the palms or soles, and though Röhrig stated that certain drugs could be absorbed from baths, more accurate observation (absorption through the respiratory tract being prevented by a layer of oil over the water) has shown that neither iodine, iodides, belladonna, rhubarb, ferrocyanides nor salicylates could be introduced through unbroken skin in watery solution (Schäfer, *loc. cit.*) and independent of chemical action on it (*cf.* Iodine, p. 71). If, however, well cleansed from grease and treated with chloroform, alcohol, ether, etc., absorption could be secured. Experiments on animals are not conclusive, since in them the openings of the follicles are wider.

PHYSIOLOGICAL ACTION.—Water, as regards quantity, is the most important constituent of the body, averaging about three quarter parts by weight of the soft tissues, and from 80 to 99 per cent. of the secretions, in which it holds dissolved salts, albumin and other proteid matters, waste products, etc. The proportion in human milk is 85—94 per cent.; in venous blood, corpuscles 681 per mille, plasma 901; saliva and aqueous humour about 987 per mille. Of solid organs the liver contains 76 per cent., muscle 74, nerve 70 to 85 (more in the fœtus), bone 46 (Schäfer). It is present also in all food to a greater or less extent. What we drink as “pure water” never is so, strictly speaking, but contains salts, carbonic acid, oxygen, and a trace of nitrogen in solution. So

much are we accustomed to this that distilled water tastes insipid and even unpleasant. Pure water is in fact a foreign body to our organism: it irritates wounds and mucous surfaces by withdrawing salts from them, and thus ceases to be quite pure as soon as it comes into contact with the tissues.

When locally applied, the cells of the part imbibe it, become swollen up, softer, and more pliable. When simply held in the mouth it relieves thirst due to local dryness, and when inhaled as vapour in bronchitis or other respiratory affections it softens the mucous membrane, and gets rid of the dry, tense feeling so often present.

In passing through the system, water (1) assists the circulation of the nutrient fluids; (2) renders oxidation and other chemical changes more active; (3) by its solvent action promotes absorption, secretion, and excretion; and (4) by its evaporation from the surface assists in regulating the body temperature. The tissue-change produced by medicinal water drinking is greater in the young and delicate than in robust adults; it is promoted by increase of temperature, whether of the water itself or of the atmosphere; also by bodily exercise (Parkes). The ultimate result of a judicious course is increase of weight, and it is said of fat (Bartholow), but if an *excessive* amount be taken, the blood is rendered unduly fluid, the corpuscles become paler and less healthy, and general nutrition is impaired.

Large draughts of *cold* water, especially if taken on an empty stomach, or when the body is heated, act injuriously, by giving a shock through the peripheral nerves to the abdominal sympathetic, and may cause nausea, faintness, syncope, and in some cases even death. Draughts of *warm* water, if not rejected by the stomach, act more quickly than cold upon the skin and the kidneys; they usually *cause* or assist vomiting, but if a pint or more be taken it will often *stop* vomiting by distending and paralysing the contractile power of the stomach. The sipping of water acts as a mild stimulant during the act of swallowing; it is also found that alcoholic drinks, when taken in small quantities at a time, have a more stimulating effect than the same amount taken *en masse*.

A certain amount of fluid taken with meals assists digestion, but too much impairs it by overdiluting the gastric juice, and

hurrying on the passage of the food. Its *temperature* is of importance, for if taken hot, especially with a substantial meal, it is liable to distend and enfeeble the stomach, whilst if iced, it does harm by contracting the capillaries and diminishing the normal blood-supply, although, indeed, a healthy stomach will tolerate, for a time at least, these and many other injurious things. Warm liquid, such as tea, taken shortly before a substantial dinner, will commonly disorder the digestive functions sooner or later, but this is, probably, not wholly due to the fluid, for a warm nutritious soup at the commencement of a meal suits many persons. If they are fatigued, it supplies nourishment in a form which is readily taken up, and enables solid food to be better digested, as it excites the secretion of pepsin. Taken later on in the meal, at the end, or an hour or so afterwards, fluids, cold or warm, materially assist completion of the digestive process, and the onward passage of the contents of the stomach. A proper amount of suitable fluid thus obviates constipation, whilst too much, especially if hot, is apt to cause that condition by impairing muscular tone. Dr. Kemslen of New York has called attention to the necessity of giving water to infants, especially in hot weather (*Med. Times*, i., 1884).

If half of our *solid* food consists of water, then the actual *fluid* to be added is about $2\frac{1}{2}$ pints (two breakfast cups and three tumblerfuls), but it varies proportionately to the amount of water passed in the *fæces*: on a bread diet a good deal is passed, *i.e.*, a good deal is taken, which is opposed to the statement that with a mainly vegetable diet there is less thirst: but certainly much meat means the need of more water to carry off nitrogenous waste (as in the "Salisbury" treatment), and conversely, at a "Nature-cure," where fruits and vegetables are cooked by steam and no salt is taken, thirst is little felt, if at all.

The total volume of circulating fluid seems to be fairly fixed, and is not to be much altered for any length of time by lessening or increasing the amount of liquid taken in health—a litre of water swallowed is almost all excreted in three hours. The interchange between the blood and tissues may, however, be hindered by excess of fluid in them—as in heart disease when the tissues become waterlogged, and a dry diet helps absorption (though if carried to excess, the more viscous blood leads to increased capil-

lary resistance). On the other hand, in fevers, the drying of the body needs dilution of the blood by more liquid.

The amount of water that escapes by the skin has been calculated at from 16 to 24 oz. in the day, but by various means this may be increased four- or six-fold.

BATHS.

Open-Air Baths.—These are an important means of treatment, at present more appreciated abroad than in this country.

At many health establishments, in Germany especially, there are large palisaded enclosures for men, for women and for children, where they remain for varying times during the day, according to season, in the scantiest permissible clothing, and occupy themselves with games and exercises to promote circulation and transpiration—and with excellent results as to “hardening,” invigorating and purifying. With less completeness, similar exposure of the skin to the air can be carried out in any room with open windows.

The theory of such a bath is simple and reasonable. The skin with its million pores is not only a heat regulator but a chief excretory organ (sweat injected into animals is, according to Arloing, four to five times more toxic than urine).

By bathing in air for a judicious time, heat is *radiated* from the naked body and in less amount than it is *conducted* away by the contact of clothing; more combustion occurs within, the blood comes to the surface sooner and more laden with combustion-products, and so internal congestions are relieved, nerve- and stomach-circulation improves, and when clothing is resumed a sense of warmth returns, to which the chilly subject has long been a stranger. So marked is this that those accustomed to the open-air bath prefer it in the snow-time.

A striking illustration of the healthfulness of the practice may be found in Nansen's book, *Through Greenland on Snow-shoes* (1891), where he describes how all thick clothes were thrown off in the tent during the evening and the natives remained nearly naked. This was on the east coast where the health standard was good, but on the west coast where Danish rule and European customs

put an end to the family air bath, and the people lived in stone dwellings, phthisis became prevalent.

Without going so far as to say with Lahmann that "since we are born naked, we cannot go clothed all our lives without being punished," we may agree that we feel instinctively the need of a freer skin, of stripping, in hot rooms or under bodily exertion, for then more blood is sent to the skin and proportionately more heat must be radiated, which the clothes worn have prevented. Soldiers marching in column and fully clothed are liable to heat stroke as at Aldershot in June, 1900, but relief is given by allowing shirt-sleeves and looser formation (*i.e.*, more radiation) and attention to head-covering. Other excreting organs, lungs, liver, kidneys and bowels can be longer hindered in their action without endangering life; if the skin be varnished the animal dies, if it be but checked in its function what it should excrete passes out with difficulty by other organs, with production of catarrh, congestion or rheumatism.

It follows that permeable clothing should be worn in conjunction with air-bathing, which will indeed "harden" the skin better than water-bathing. In warm weather it is easy enough, but the effect is really better in the cool or cold; anæmic and weakly people should begin with only five minutes' exposure night and morning, and increase gradually; a slight catarrh may follow for a time, but as a rule this bath frees from any serious bronchial cold, and when accustomed to it, open windows have no terrors; on the other hand chill often follows an overheated bath, and perspiration breaks out when the clothes are put on; after air baths one takes readily a water bath in the open air.

Water Baths may be simple or medicated, cold, warm, hot, or in vapour, local or general. Their action varies much according to the temperature, and the length of time and form of application.

The Cold Bath.—Under this head are considered baths the temperature of which varies from about 40° to 60° F., according to the season of the year. When entering a cold bath there is a sudden feeling of chilliness with roughening of the skin (goose-skin), some blueness of the lips, catching of the breath, and lowering of the pulse. But in a few moments, in fairly healthy persons (and only such should take this form of bath), "reaction" sets in, with a sense of warmth and exhilaration, quickening of

the pulse and respiration, and augmented muscular power. The first effect is due in a measure to altered conditions of the circulation (the superficial vessels being for the moment contracted, and the internal parts congested), and in part to the sudden shock felt by the large expanse of the sensory nerve-endings in the skin. A familiar illustration of the reflex effect of cold is presented when one hand only is immersed in cold water: the vessels of the opposite hand are contracted by reflex action, and its temperature also falls. That the blood supply of internal organs may be controlled by external applications is proved, *inter alia*, by the observed contraction of renal arterioles when ice is applied to the lumbar region (Brown-Séquard) and by the immediate diminution in the volume of a congested liver and spleen under the influence of cold douching (Fleury).

Mosso and Bergesio investigated the effects of hot and cold baths upon the cerebral circulation in a patient who had sustained a fracture of the skull; a piece of bone was removed, and the cicatrix which covered this area was observed to rise and fall with the heart-beat, and with each respiration. Tracings of these movements confirmed Schüller's experiments on rabbits, which showed that cold baths increased and warm baths diminished the amount of blood in the head; and it was found that the effect of the cold bath could be divided into two stages. In the first, lasting only a few minutes, the force of the heart was increased, but the frequency of the beats diminished; in the second stage, there was still a slow pulse, but its size was lessened, whilst the brain gradually became larger, as shown by the swelling up of the cicatrix (the contraction of cutaneous vessels leading to determination of more blood to the head).

The general effect of a short and satisfactory cold bath is "tonic." The blood circulates more freely, and tissue change is increased; yet, concurrently, appetite and digestive power are so far improved that during a course of such baths weight is commonly gained. Winternitz observed decided increase in the percentage of red corpuscles of the blood as the result of general application of cold to the body surface, also increased assimilation of oxygen and excretion of carbonic acid (*Centralbl. f. klin. Med.*, 1893, xiv.; *cf.* Ziemssen, *Handbk. Gen. Therap.*, vol. v.).

The *prolonged* cold bath, used only through imprudence by the

healthy, or for definite curative results in the hyperpyrexial patient, has a very different effect. The primary reaction is succeeded by coldness, depression, weakened circulation, and an exhaustion which may progress to collapse. The temperature is steadily lowered, the blood accumulates in the great venous trunks, capillary circulation and tissue-change generally are interfered with, and reflex symptoms, such as nausea, vomiting, and syncope, may follow.

Pugibert and Bailey have described a scarlatiniform flush, limited or diffused, as due to the cold bath. According to two cases reported by them, this rash is the precursor of shivering, lividity, and a syncope which might prove fatal if it occurred in deep water (Med. Record, 1879). In the clinical use of the cold bath, which is a method now largely employed for the reduction of pyrexia, such results are avoided by careful watching and thermometric observation.

Sponging.—Wet Towels.—The Wet Sheet.—Perhaps the simplest application is the sponging of the whole body as the patient lies in bed, afterwards being warmly covered, but more effective is the use of towels or a sheet wrung out, and applied with vigorous friction; it is free from the risk of serious shock to delicate subjects, and is commonly and properly applied before commencing with cold immersion.

The *towel friction* is given first to the upper part of the body whilst the patient sits with the lower limbs still covered—that is to say, the whole surface is not exposed at one time. Where there is a feeble state of circulation, or when the breathing is oppressed, the water may at first be at 80° or 90° F., and gradually lowered to cold, and more of it left in the towel as the power of reaction improves. Under this “graduated stimulation,” a pale, bloodless, and sensitive skin may be educated to a good power of reaction, with marked relief to chilliness and to the frequent recurrence of catarrh, and there are scarcely any patients—certainly none who retain the power of taking and digesting food—that cannot receive towel-rubbing with advantage. In catarrhal subjects, however, special care should be used in avoiding exposure at first, or harm may result.

The *wet-sheet friction* is somewhat more trying, since it should always be used cold, and the patient stands, quite uncovered,

whilst the sheet is thrown over the shoulders and round the whole body, and friction is applied by making folds in the sheet, not by simply rubbing the smooth surface. This should be continued for two, three, or four minutes. It is suitable for persons not much accustomed to cold water, but with a fair amount of vital power. It relieves fatigue, and may be taken when a cold bath would be unsuitable; it relieves, also, nervous depression and early stages of catarrh and neuralgia. The use of a warm sheet, unless followed by a cold one, is not attended with any of the good effects of this kind of bath. By a sheet so wet as to be "dripping" a more powerful effect is exerted, whilst by wringing the sheet very dry from the cold water, quicker reaction will be ensured: the patient should not attempt to rub himself much, or make any violent exertion during this process, otherwise he may be troubled with giddiness or palpitation.

Shallow Bath.—This is given with about six inches of water in a bath long enough for the patient to sit with the legs in, though he need not lie down. The so-called "half-bath" is similar, but with a greater depth of water which should be splashed, rubbed, and thrown over the body by means of a towel used by an attendant at the back, while the patient splashes in front, for from one to five minutes, according to the reactive power. The frequent change of the splashing water against the body lowers temperature for the moment, and vigorous friction is required afterwards, or walking exercise. The same bath, more or less completely given, is the ordinary morning "tub" of average Englishmen, and exerts an excellent tonic and anti-catarrhal effect. During acute febrile disorder the shallow bath may be used at 70° to 80° F., and much exertion is not desirable, nor is friction required; but in the absence of acute disorder it should always be taken cold in summer, or at about 60° F. in winter, and be followed by exercise. Some persons persist in taking their morning bath cold, *i.e.*, of the temperature of the air, however cold it may be. This does no harm to extremely vigorous constitutions, but it is a dangerous example for those to follow who are less strong, and to whom the shock of intense cold may be the very reverse of beneficial. The ultimate effect of the judiciously used morning bath is to equalise circulation, but it encourages it especially in the lower extremities, and so relieves the head and the viscera.

The Pail Douche is administered by throwing two to four pails of water (six or eight gallons at a time) over the shoulders, against the back, or the front of the chest, as the patient sits in a long bath: a dry-towel friction follows. This process adds the shock of dashing water to the splashing of the shallow bath, and imitates to some extent the wave-stroke of open-air sea-bathing. It needs more power of reaction than the baths already mentioned, and, if well borne, is more effective. The amount of force, and the number of pails, should be varied with the condition of the patient.

Spinal Washing.—This is a mild and local form of douching from a jug, or can, or large sponge, emptied along the spine, as the patient sits on a board placed across the front of a bath. It may be continued from two to ten minutes, and sometimes should be commenced at 80°, and gradually cooled down, until after a few baths it can be borne wholly cold. If commenced too cold, in sensitive subjects it may give rise to headache or giddiness, and if continued too long may induce a rheumatic condition of the back muscles, and is not free from risk to the kidneys. It would seem that the spinal cord is directly stimulated by the shock of cold water, and that the stimulus is reflected to peripheral and visceral nerves, notably the sympathetic ganglia. This bath is useful in functional torpor, with numbness or slight paralysis of limbs, constipation, and phosphaturia, etc., producing a bracing effect and pleasant glow as it does, especially if followed by manual friction, and the effect may be further developed by the use of a “rubbing wet sheet” to the whole surface for a few minutes afterwards.

The Douche.—This, the principal form of the “impact bath,” is the most powerful within the domain of hydro-therapeutics, and has been made the basis of the system practised with much success by Drs. Fleury and Veillot at Bellevue (Paris) and other French physicians. Its effect in stimulating the circulation and the nervous system varies with its size, force, direction, duration, and temperature. It may be a column of water from one to three inches in diameter, falling twelve to twenty feet, or propelled at right angles to the patient’s body, or “ascending”. It may be broken up into fine streams by a rose (*Strahl-douche*) or into more numerous jets, arranged to play at once on the body from different

quarters (*douche du cercle*—needle douche). Again, it may be used tepid, hot, or cold, or all three at one sitting, and its duration may vary from ten to sixty seconds, or in healthy people more. As a rule a feeling of exhilaration is produced which lasts for some time. Edgcombe and Bain found that a strong needle bath graduated from about 99° to 60° caused decided quickening of pulse, rise in arterial and slight fall in venous blood pressure (Lancet, i., 1899). These effects are attributed to (1) peripheral vascular constriction; (2) increased cardiac output. The effects of combined massage and warm douching, as at Aix, are the reverse, *i.e.*, fall in arterial, rise in venous pressure with slowing of pulse.

The cold douche should be commenced cautiously, after due estimation of the patient's reactive power, and if there be much debility, it should be applied at first to the extremities only, and for a very brief period—ten to fifteen seconds: this is a most important point: a douche which consists of a single column of water should under no circumstances be allowed to fall on the head. In disease, the douche is, as a rule, suitable only for chronic cases, but with careful management may be applied to almost all conditions.

According to Fleury the general douche, in shower, jet, or circle, is powerfully tonic, by virtue of its action on the circulation; with an increased force of percussion, rapid movement from one part to another, and fine division of the liquid, a more exciting effect is produced. By directing the stream upon various parts in such force as to congest them, a revulsive action is made to relieve the congestion of other parts; thus, metrorrhagia and vomiting, even when dependent upon a uterine polypus, have ceased under a course of cold douching, and the volume of the liver and spleen has markedly diminished. Andral and Piorry considered that they had verified the extent of hepatic dulness in a certain patient as 18 centimètres (vertical) and 11 centimètres to the left of the median line (horizontal), and agreed that immediately after an energetic douche, the former measurement was reduced by $\frac{1}{2}$ centimètre, the latter by 5 centimètres; and in another case, the spleen, which measured at the commencement of treatment 23 centimètres vertically and 15 transversely, measured only 9 and 7 centimètres respectively after six days of repeated local douching. The effect on other organs is said to be similar, though less rapid.

In certain disorders, such as dropsy or effusion into joints, *absorption* has been markedly stimulated by the douche.

A milder form of douche (affusion, local and general) is given by the watering-pot of Pfarrer Kneipp, whose crude methods have been elevated into a system still popular, mostly on the continent, but practised also in several establishments in England.

A douche with friction (*Frottir-douche*) is used in German hydropathics, and a still more active form, the "change," or "Wechsel" douche, wherein a powerful stream first of hot, and in twenty to thirty seconds of cold water is directed on the affected part, such as a dilated colon, whilst the patient lies in a long bath from which the warm water has been gradually drawn off. A steam douche is used for local application, *e.g.*, in lumbago.

The Sitz Bath.—A valuable influence may be exerted not only on the pelvic organs, but indirectly on the whole system, by sitting in water of varying depth and temperature (60° to 80° F.) for a time varying from five to thirty minutes. The sitz bath may be taken cold or hot. In either case it "draws blood from the brain," and is one of the best means of ensuring sleep. It relieves fatigue, improves appetite and digestion, lessens headache and giddiness, regulates the bowels, the uterine flow, and the action of the kidneys, often augmenting these when deficient, or lessening if excessive.

To obtain good effects after a cold bath, it is most important that thorough reaction be secured by friction, or exercise, or warm clothing, otherwise shivering and depression come on. It may be advisable to commence with *tepid* water, or a more powerful stimulus may be given by a "running sitz," fresh cold water constantly entering the bath and circulating round the body. Or again, a local upward douche may be made to act upon the lumbar region, the perineum, the uterus, etc., whilst the ordinary sitz bath is in progress. The *general* effect of the cold sitz bath is sedative. It slows the pulse to the extent of ten or fifteen beats during the first five minutes—of twenty beats in the course of half an hour (H. Johnson). It also lowers the respiration, though very slightly, and lessens the body temperature. By its rube-facient effect, the sitz bath also acts as a derivative or counter-irritant.

Foot Baths.—The immersion of the feet in water produces some of the effects of the sitz bath, but in a minor degree. For all purposes the thorough-going hydropathists use foot baths *cold*, or at least cool, with considerable friction, but there are some subjects in whom the *cold* to the feet produces serious symptoms, and others—such as gouty and catarrhal patients—in whom a *hot* foot bath, to which mustard or pepper may be added, relieves, and under due precaution as to exposure, does so more pleasantly and effectually than the cold. Friction of the feet with a “damp or dripping towel” is, however, an intermediate method often available. Drs. Mosso and Bergesio found in their patient that the effects of hot and cold *foot baths* on the cerebral circulation were the same in kind as, but less in degree than, those obtained from *complete* immersion in hot and cold baths respectively. The hot foot bath dilates the vessels of the lower extremities, pelvis, and skin, and frequently induces copious perspiration; it is often used to obviate the effects of a chill and for the same purposes as the hot sitz bath. The “change foot bath” is now in frequent use in hydropathy, and is given by putting the feet for about half a minute at a time in hot and cold water alternately.

Hand Baths.—Dr. Vasilieff has described the physiological effect of hand baths, *i.e.*, placing patients' hands in hot or cold water. He made 100 observations on forty-three patients, the duration of the bath lasting in each case from fifteen to thirty minutes. Under hot hand baths, the temperature (taken in the ear) rises, the pulse and respirations become more frequent, the tension in the blood-vessels is increased, and the colour of the fundus of the eye becomes darker (probably from dilatation of the veins). Cold hand baths produce a lowering of temperature, pulse, and arterial tension; the fundus deepens in colour, the respirations become deeper, but their frequency is not altered. The general conclusion is that hot hand baths increase, and cold hand baths diminish, the amount of blood in the head. Three cases of epistaxis were arrested by the application of an ice-water hand bath in each case (Record, 1885).

The Ice Cap.—This is a rubber or gutta-percha bag which can be filled with ice; it is a soothing application to most cases where headache is a troublesome symptom. It also lowers the temperature of the whole body, perhaps by its action on the

thermal centres situated in the brain. A convenient form of cap is made of a coil of india-rubber tubing through which ice-cold water is allowed to flow (Leiter's tubes).

In the Pack Bath or Sheet Bath the whole body except the head is enveloped in a sheet wrung out of cold or tepid water, outside which are wrapped one or more blankets. The first feeling of cold soon passes off, the sheet and water become heated up to the body temperature, and the body is surrounded by water vapour. Profuse perspiration follows, which is increased by drinking water, and this is one of the surest ways to induce diaphoresis. The respiration is not impeded as in the vapour bath. It may be continued for half an hour to an hour or longer, is easily applied, and should be followed by tepid sponging.

There is more discomfort, with chilliness and depression, produced by the routine use of this agent in hydropathic establishments, than by any other measure. In febrile conditions it may be of the utmost value, but even in such cases I have seen serious results from the exhaustion induced. The *hot pack* is sometimes better.

Wet Packing.—To avoid unduly rapid depression of circulation and general activity, it is often advisable to commence with a *partial* packing, *i.e.*, closely applying to various parts folded towels wrung from cold water, and covered with flannels and waterproof sheeting. Thus the hips and loins may be "packed" from the level of the navel to half-way down the thighs; the abdomen, from the lower edge of the ribs to the hips; the chest proper, over the ribs, or the whole front and back of the body: it is said that packing applied to the chest exhausts more than packing of other parts of the body (Gully). Again, packing of the lowest part of the belly and back, of the whole spine, or of the sides, are other varieties. The wet towels may be changed every fifteen to twenty minutes for an hour or two.

Sponging the whole body while the patient lies on waterproof and blankets is a refreshing form of bath for invalids, and is systematically employed in febrile cases for reducing temperature. Sometimes tepid water will effect this, cooling it down to ice cold for a short time if necessary. Some stimulant and the after application of friction to the limbs and warmth to the feet may be used as well as dry towels or blankets.

Compresses are partial packings, *e.g.*, over the stomach for dyspepsia or insomnia, on the abdomen for constipation, or over joints for pain. They prevent and relieve irritation. Sometimes they are used without coverings (which prevent or lessen evaporation), and by changing them more or less frequently a comparatively low temperature may be maintained.

Thus a sedative effect is produced, *e.g.*, in congestions of the testis or uterus by changing every five minutes for an hour; in contusions, every half-hour; in inflamed throat or lung, or chronic gastric irritation, every six to ten hours; in acute bilious attacks, every two hours. Cold applied over an artery causes it to contract, as shown by Winternitz, but if a compress be allowed to get too warm, like a poultice, it may stimulate and even irritate some cases.

A convenient form of very cold compress is the ice poultice. This is made by enclosing finely powdered ice in a piece of gutta-percha tissue, the edges of which may be made to firmly adhere to one another by moistening them with chloroform. A long ice poultice applied along the spinal column is most useful in reducing temperature. The well-known ice cap has the same effect through the head centres, or cold water may be made to circulate through coiled rubber or metal Leiter's tubes.

Water Beds.—From the equal pressure they exert on all parts, water beds are well adapted to prevent or ameliorate bed-sores. For ordinary use they should be filled with warm or tepid water, but beds containing cold water changed every day or oftener are well adapted as a mild but effective method of applying the cold-water cure to cases of fever, as they abstract heat from the patient lying on them. In some cases it is advisable to have cold water running through the bed continuously; in such a bed one must always take the precaution of seeing that the circulation through the bed is free, for if the outlet pipe gets blocked or kinked the bed may become overfull and burst.

Warm Baths.—By an action contrary to that of cold baths, these *attract* the blood *primarily* and directly to the part exposed to their influence, relaxing the vessels and tissues, and leaving them afterwards in a condition of lessened tonicity. A similar effect is exerted by all kinds of warm baths, but it differs in *degree* according to the temperature and duration. By a *tepid* bath is meant one from 70° to 80° F., and this is chiefly used

for cleansing and moistening the skin—a temperature of 92° to 98° F. gives a *warm*, and upwards to 112° a *hot* bath.¹ With the former there is at first a pleasant sense of soothing and refreshing warmth, the skin reddens, and the pulse quickens in frequency, whilst it lessens in tension; the respiration is also quickened, and the temperature rises. If the bath be too prolonged, a sense of languor comes on, and after it there is less aptitude for exertion than before. Under favourable conditions, excretion is increased from the skin, the kidneys, and the lungs, at the time of the bath, and oxidation is lessened subsequently. Drs. Mosso and Bergesio found that the effect of the warm bath on the cerebral circulation was divisible like that of the cold bath into two periods: the first stage lasting only a few minutes was characterised by increased energy of the heart, and an increase in the volume of the brain; this was speedily followed by diminution of the heart's force, and a shrinking of the brain. The cerebral anæmia, to which this was due, moreover, lasted a considerable time after the bath.

In a **Hot Bath**, 98° to 112° F., the first sense of heat may be painful rather than pleasant, then a general stimulating effect is perceived, the whole surface becomes deep red, and the cutaneous veins distended. Complete muscular relaxation follows, with greatly diminished tension of the pulse, and increased frequency of the heart's action; relief is thus given to internal congestion, pain, muscular spasm and convulsion. Before very long, a sense of oppression and distension may be felt in the chest and head with general languor, giddiness, or faintness. These unpleasant effects occur much sooner in some persons than in others.

By a hot bath perspiration is usually, but not always, increased; and sometimes from the high temperature of internal organs a restless, heated condition similar to that of true pyrexia may be induced for a time. This may be noticed, especially after a too prolonged use of the hot strong saline baths (Droitwich).

The length of stay in a hot bath should depend on the purpose to be accomplished, whether (1) mere excitation of circulation in the skin (which is effected by a short bath with or without the extra stimulus of salt or mustard), or (2) perspiration and relief

¹The Nauheim bath is usually ordered at about 90° F., and contains sodium chloride up to 3 per cent., calcium chloride up to $\frac{1}{4}$ per cent. with CO₂ up to 73 cc. in 100 grammes, and has special effects.

of pain (which require, perhaps, half an hour), or (3) complete muscular relaxation, or skin cleansing and sedation (which needs a prolonged immersion, *v. p.* 189). In contra-distinction to the ultimate tonic effect of the cold bath, decided loss of weight results from a course of warm bathing (A. Steffen).

Contra-indications. Since the thoracic organs and the brain become more or less hyperæmic during a hot bath, its prescription needs as much caution as that of cold bathing, though for a different reason; pulmonary or cerebral vessels may give way, especially if they be atheromatous or the seat of aneurism. According to Dr. Steffen, hot-water baths are pre-eminently contra-indicated by congestion or œdema of the lung, and Dr. H. Wood has seen, under such conditions, "the most frightful dyspnœa result" (in such an accident, cold affusion should be freely used). On the other hand, broncho-pneumonia has been relieved by hot mustard baths.

Hot Fomentations and Poultices.—These are local hot baths, and are convenient methods of applying heat and moisture. As cold water may be usefully applied in local compresses, hot water is often of the greatest service applied in fomentation, *i.e.*, when a thickly folded flannel, or any thick absorbent substance such as spongio-piline, is completely wrung out of hot water, and placed on the affected part, covered with dry flannels, oil silk, or mackintosh outside, to prevent evaporation and retain heat, and changed again frequently, the process being continued for half an hour, or even for several hours if necessary. This stimulates the external skin much more strongly and suddenly than any cold compress, for every degree *above* the normal temperature of the skin is felt much more acutely than every degree *below* it (Gully), and it acts much better than the more equable heat given by hot salt, hot bran, or tins, or caoutchouc bags of hot water, because the high temperature is more constantly renewed. Hot fomentations will also be found to be more cleanly than hot poultices, and bring about the same results equally well; they may be medicated with turpentine or belladonna, etc.

If there be congestion, or even inflammation of an internal organ, it may be relieved by such external applications which are especially indicated when the patient is too feeble to react to cold, or when the pain and irritation are very severe. The direct appli-

cation of quite hot water causes contraction of small vessels in the part treated and also of the uterus (*v. p.* 187).

Dry or Blanket Packing.—In this process the patient is enveloped in six blankets, one at a time, each accurately adjusted about the throat and feet, so as to be air-tight; a feather bed is thrown over all. Dr. Howard Johnson speaks highly of this treatment, which he credits with producing the same results as vapour or Turkish baths, without so much general perturbation. After a time, the air next the skin is so far heated as to excite the circulation, and stimulate a flow of perspiration, and after this has lasted for half an hour or an hour, a shallow bath at 70° or 60° F. and a dry friction complete the process. (The hot wet blanket is also used.)

Though weight is temporarily reduced and excretion increased by this, as by other warm baths, it does not necessarily follow that the general condition is impaired; on the contrary, in satisfactory cases, even after profuse sweatings, weight is ultimately gained owing to increased appetite and assimilation.

Vapour Baths.—The vapour of water, in the form of the steam bath, lamp bath, hot wet packing, or Russian bath, may be used to accomplish still more thoroughly the same objects as those to be expected from the warm or hot bath. In one good form of vapour bath, the patient sits unclothed in a box to which steam is admitted, but the head is outside, and covered with a cold cloth. At Wildbad this is known as the Russian-Irish bath. In a less complete, but more portable form, the patient sits on a chair covered with blankets, whilst steam is generated by a spirit-lamp placed under a pan of water: or a somewhat similar result may be obtained by dropping freshly burned lime into a bucket of water under the chair, or a heated brick into hot water; or if the patient be too weak to rise, steam may be conducted under the bed-clothes raised by hoops; or a heated brick or bottle wrapped in moistened cloths and flannels laid near each limb, or any limb may be steamed separately in a suitable apparatus. A steam douche and steam spray are also used locally, *e.g.*, for lumbago. The most complete form of such bath is, however, the Russian bath, which is given in a closed chamber filled with steam. On first entering the bath there is often a disagreeable sensation of heat and burning in the skin, the pulse becomes quick, and respira-

tion uneasy; sometimes there is a feeling of pressure in the eyes, heaviness in the head, and dizziness, especially if the temperature is much over 100° F.; at the usual 80° to 90° F., these symptoms soon pass away, and the respiration becomes more natural and deeper, the blood finds easier access throughout the body, the skin soon gets red and moist, and the patient comfortable.

Dry Heat, Hot-Air Bath.—Dry heat may be applied by metal or earthenware vessels or flexible tubes containing incandescent materials or hot liquids, by heated metal plates, etc., or preferably by electric thermaphore—such as that of Cerruti of Turin—which consists of a special-cloth pad, containing wires which can be connected with an ordinary electric lampholder and regulated as to heat by a switch. The simplest form of this bath is much the same as described under vapour bath (without the water), and is perhaps most frequently used for patients in bed—the heated air from a suitable lamp or gas stove being conducted under the raised clothes. The more complete form in which, as in the Russian, the whole body is exposed to heat is the Turkish.

The Turkish, or Anglo-Turkish Bath, in which dry *air* at a much higher temperature, *viz.*, of from 100° to 160° F., or more, is employed, the patient passing through two or three graduated chambers during twenty to forty minutes; when free perspiration has occurred, and lasted for some time, shampooing is commenced, and afterwards the body is washed with copious lathers of soap and streams of water, warm, tepid, and finally cold. The effect of the warm applications and frictions is to stimulate both the general and cutaneous circulation, to relax the muscular tissue, relieve pain and congestion, to cleanse the openings of the skin glands, and to eliminate through them morbid material and retained excretion. That the skin excretes urea has been proved by finding it in the perspiration of healthy persons (Landerer, Funke, Leube, etc.); but still more constantly in cases of scarlatina, nephritis, cholera, collapse, and chronic Bright's disease (Scottin, G. O. Rees, Fiedler, etc.). In such cases the urea may even form a crystalline powder on the skin, especially near the sweat-glands (H. Wood). Moreover, in diabetes the perspiration contains sugar; in rheumatism, lactic acid; in gout,

uric acid ; and in jaundice, biliary products.¹ This being so, it is evident that the promotion of very free secretion from the skin-glands by the varied processes of the Turkish bath is a most efficient means of depurating the blood. The effect of the final cold douche or plunge is to contract muscular tissue both in the skin and deeper parts, and to stimulate and brace up the nervous system ; hence this form of bath combines the good effects of both hot and cold applications. It should induce an agreeable sense of vigour and elasticity, and render the skin less sensitive to changes of temperature.

It does not, however, always succeed well ; in some subjects, especially at first, sweating is not favourably induced, and they suffer from heat malaise, and headache ; the use of a wet towel with friction should then be tried, or gentle douching with warm water on first entering the bath ; the head should be kept wet and the feet some time in hot mustard and water ; syncope may be averted by cold wet cloths to the precordia. Drinking cold water is also recommended for increasing the skin secretion, and often succeeds, but in my experience it has sometimes caused nausea and gastric pain. Persons vary in their power of resisting heat, and although there are really few who cannot go through a Turkish bath with safety, there are many who suffer at first from some degree of oppression, faintness, and exhaustion with after headache. Hence, the first bath should be taken cautiously, not prolonging unduly the time in the hot chamber—say not beyond twenty to thirty minutes (the sensations will practically guide as to time), and finishing with the cold, or nearly cold, douche for a few seconds only, not with the plunge bath. It is a mistake to go overfatigued into the Turkish bath, or within three or four hours after a good meal ; or to dress too hurriedly, and go with still perspiring skin into the open air.

The following Methods of using the Turkish Bath have been suggested by Dr. Whitby.—(1) Full bath : go first to the “flue room,” hottest (160° to 200° F.), remain till slight oppression is felt, then go to the hot room (130° to 150° F.) by the same rule.

¹ Arloing and others have shown that the toxicity of sweat is variable and is increased by conditions (*e.g.*, muscular effort) which raise the toxicity of the blood (B. M. J., ii., 1897).

Remain afterwards in the warm room (115° to 130°) till free perspiration occurs—the whole occupying forty to sixty minutes.

(2) Ordinary bath: the “flue room” first for six minutes, the hot room next for fifteen minutes; then the warm room for ten minutes more or less. (3) Brief bath: the hot room for ten minutes, then the warm for ten minutes. (4) Mild bath: the warm room for twenty minutes. (5) Five minutes in the warm room, as preliminary to some other bath (Hydrothermal Procedures, Bristol Med. Chir. Journ., March, 1900).

Methods of Concluding the Bath.—(1) By general shampooing and soaping, followed by spray or needle bath—finally a plunge. (2) A hot soap down without shampooing, followed by needle or spray. (3) The latter bath only. (4) In cases of debility a tepid sponging may suffice.

The Effects of Heat on the organism may be summarised thus: (1) The temperature is raised, more by moist than dry heat. Eulenburg states that the steam bath raises the body temperature to a very appreciable degree; on an average a steam bath of 41° to 42° C., by $1\frac{1}{4}^{\circ}$ to $1\frac{1}{2}^{\circ}$ C. (Real-Encyclopædia, 1880, i.). (2) Dilatation of skin arterioles and capillaries and subsequent contraction of deeper vessels, especially in the splanchnic area; depletion of abdominal viscera. (3) More or less acceleration of heart action, due in part to diminished peripheral resistance; the excitant effect of moist heat is greater than of dry. (4) Diaphoresis and fall in mean arterial blood pressure. (5) Increased respiratory activity and oxidation of waste products with modified toxicity. (6) Increased renal activity and elimination of urea and uric acid. (7) Relief of arthritic and myalgic pain if present.

Drs. Frey and Heilgenthal instituted experiments to determine the relative effects and value of hot-air and steam baths in the establishment at Baden-Baden. They found that the general effect of both was the same, namely, an increased sensibility of the skin both to tactile and thermal stimuli; the primary contraction of arterioles was followed by dilatation with fall of blood-pressure; respiration was but little affected; perspiration was more profuse in the air bath; the body temperature rose; the urine was diminished in quantity, but its specific gravity increased; and there was a loss of weight, which was more than made up by increased assimilative power. They found these effects to be produced more readily, and

in a shorter time, by the vapour bath than by the hot-air bath ; the vapour bath, in other words, is more violent, and, therefore, those with feeble constitutions should prefer the hot-air bath (Record, 1882 ; also Monograph).

In 1893 Tallerman showed that higher temperatures could be utilised in dry air by means of a metal cylinder heated by gas jets, closed at one end, except for a ventilator to secure escape of moisture ; into the other end the limb or part to be treated was introduced, and packed round externally by a special cloth screen ; the temperature within could then be raised to 220° to 250° F., without burning, or much rise of pulse or temperature of the body—generally with profuse local or general sweating, though this, and the occasional faintness and headache might be accounted for by having to remain in an atmosphere heated and vitiated by gas.

The Greville apparatus somewhat resembles the Tallerman in principle, only that the source of heat is electricity passed through metal threads fixed between two partitions ; equally high temperatures can be obtained without the drawback of gas emanations.

In the “ Radiant Heat and Light Bath ” of Dowsing still higher temperatures can be used without serious discomfort. Some patients, however, complain much of burning sensations, especially those who suffer from varicose veins. The electric lamps used are made of ground glass of various shapes containing a special form of metallic filament in vacuo, which may be connected with continuous or alternating currents of any voltage, and are set in wedge-shaped copper reflectors adjustable to any position for directing the rays on the body or any part of it. For a “ general bath ” the patient lies, more or less covered, on a mattress with four long lamps on each side which soon reflect on to the body light rays of a temperature of 250° to 350° F. Perspiration becomes free, and after thirty to forty minutes the patient is dried with warm towels and then allowed to rest till cool. The pulse and temperature, which have been moderately raised, though less so than in the Turkish bath, return to normal within the hour, and no prostration is complained of, rather the reverse. In local radiant baths for single limbs a temperature of from 400° to 500° F. has been used with benefit ; though luminous heat rays are more active and

penetrating than those of dark heat, they can be directed on the body without heating the surrounding air.

Sun and Light Baths.—To some extent the ordinary air bath in the open in summer is also an exposure to sun and light, but the real “sun bath” is prepared on the roof or other fully exposed unshaded place, where the patient lies on a mattress with a slight head protection and either “free,” *i.e.*, quite unclothed, or closely wrapped up according to the effect desired, and for an hour, more or less; the process being completed by a tepid and cold sponge. In the proper “light bath” the patient sits in a covered box when a high degree of electric heat and light, either incandescent or arc, is concentrated on the body or parts of it, the head being outside.

In both forms of bath, light and heat penetrate the skin (sometimes causing erythematous and follicular rashes), destroy bacilli, increase pigment and corpuscular formation, perspiration and tissue—change generally, and consequently appetite and activity of organic functions, relieving neuralgic and rheumatic pains and lessening internal congestions of various kinds, producing effects similar in kind to those of Turkish baths, etc.

Electric Baths. — Besides the ordinary applications of electricity, the currents may often be used with more advantage combined with baths of which four kinds may be mentioned (Whitby). (1) Galvanic full bath (in wooden or earthen tub) at 98° F., with an uninterrupted current of from 100 to 200 milliamperes passed from feet to head for fifteen to twenty minutes: it is calculated that about $\frac{1}{8}$ part traverses the body. A slight pricking sensation may be felt at the large joints and warmth near the negative electrode. (2) Alternating sinusoidal, as above, but with the alternating current from the main, modified by a transformer, gradually increased in strength short of contracting the muscles, then diminished. (3) The above combined, both currents being simultaneously passed along the wires. (4) Foot-bath—one flat electrode at the bottom of an insulated bath—the other, a large damp sponge held in both hands.

Erb (1887) describes from such baths effects very similar to those already mentioned from other stimulating forms of bath, except that “respiration is diminished,” notably “sleep is restored and new vigour imparted.” Dr. Hedley corroborates his favourable

opinions with much additional knowledge (Hydro-electric methods). He has shown that electricity can be conveyed through the stream of a douche (Lancet, i., 1892). Another and newer form not yet generally known is the electrical four-cells bath of Schnée, in which a separate bath is used for each extremity and the current can be conducted in a determined direction through any part of the body.

The Light Treatment of Lupus.—The generally beneficial effect of sunlight has for ages been recognised, but within recent years Dr. Finsen of Copenhagen has differentiated the therapeutic value of the different rays composing the spectrum. He found that the violet and ultra-violet rays of the spectrum—the so-called chemical rays, were more active in promoting the development of the fertilised eggs of the amphibia, and as a corollary he found that by excluding the chemical rays by means of red glass the cutaneous lesions of small-pox were greatly ameliorated. He and others also found that the chemical rays had a very marked bactericidal action on various artificial cultures of micro-organisms. As a further step it was observed that these chemical rays could produce a chemical effect through the skin, as shown by their power of darkening nitrate of silver introduced under the living skin. He and others have now successfully treated lupus vulgaris and some other diseases of the skin by means of concentrated and cooled sun- or electric arc-light. Hitherto, in view of the fact that in northern latitudes the supply of sunlight is inconstant, the electric arc light (which is rich in chemical rays) has been the chief source of the therapeutic rays, and their necessary cooling and concentration, as well as their administration (requiring skilled attention for about an hour each day for each patient), has involved an expense of money and time not within the reach of the ordinary medical practitioner, but this drawback is being eliminated.¹

The method is probably the best of any extant for the treatment of lupus (although three or four others give nearly as good results

¹ For details as to the technique of treatment, reference may be made to Dr. Finsen's writings (or to the translation of his book by Dr. J. H. Sequeira) and to several articles in the British Medical Journal of the following dates, 30th Sept., 1899; 4th Jan., 9th Feb., and 8th June, 1901; 11th Jan. and 12th April. 1902, etc.

at a much less cost) and it is especially applicable for lupus of the face, because the scar it produces after healing is flat and comparatively little disfiguring.

The same rays have been used with good effect for such conditions as rodent ulcer, epitheliomata of the skin, alopecia, favus, and other parasitic skin diseases. Lupus erythematosus is not so amenable to this treatment.

Along with many advantages over other methods the light treatment has the following important drawbacks. It is slow in its effect and is liable to cause an obstinate dermatitis; a permanent result cannot be assured; and it is not easy of application to mucous membranes. The slowness is being removed by improvements in the matter of lamps; for example, by the Lortel-Genoud lamp an equal effect is now obtained in ten minutes to that which required sixty by the old lamp. The rays can to some extent be applied to mucous membranes, *e.g.*, to the nose, by means of bevelled compressor or lenses applied direct to the diseased surface; but a useful combination in cases of disease of the mucous membranes and skin is the Röntgen rays with the chemical rays. As with all other methods relapses do occur, but they are probably less frequent than with them, and the rays can always be easily and effectively re-applied. There is no special danger in treating diseased tissue in the neighbourhood of the eye.

Malcolm Morris and Dore point out that there are certain conditions which render a case unfavourable for treatment by Finsen's method. They are:—

1. Those which hinder the penetration of the light, and so prevent a good reaction: (1) *Scarring*, especially from scraping, when the cicatricial tissue is, as a rule, very dense. (2) *Pigmentation*, which intercepts the ultra-violet rays. (3) *Great vascularity with discharges*, because it is more difficult to express the blood from the part, and unless the tissues be made anæmic the rays will not penetrate. (4) *Great depth below the surface*, with which may be included: (a) Thickness and induration of the nodules; (b) surrounding inflammation and induration; (c) confluence of the nodules.

2. Difficulties of position: (1) *on the skin*; for example, when the disease is situated near the eye special compressors have to be used, and it is sometimes difficult to adapt even these to the surface

to be treated, or on the eyelid, when it is impossible to apply adequate pressure. (2) *on the mucous membrane*: the interior of the nose and mouth is inaccessible, with the exception of the gums and lips, which can be treated, the latter by eversion. (In these cases the combination of X-rays with Finsen's treatment has been found most successful.)

3. Extent of the disease: as only a small area can be treated each day, very extensive cases are unfavourable, both from the long duration of the treatment, and the fact that while one part is being treated the disease may be spreading in another.

Conversely, cases are favourable where the disease is limited to a small area, is superficial, is not spreading, and has not undergone previous treatment, especially operative.

The advantages of the method may be briefly summed up as follows: Reliability, excellent cosmetic results, less liability to relapse, although this may possibly be due to the fact that the patients are under daily treatment and constant supervision; avoidance of surgical measures. It may also be a useful adjunct to other forms of treatment.

THERAPEUTICAL ACTION.—The curative effects of the different forms of hot air and galvanic baths are perhaps sufficiently indicated in the account of their action, but it should be added that they are used also in *general affections* such as anæmia and chlorosis, and in diathetic disorders such as obesity, as well as in gout, rheumatism and neuralgia. The following pages deal mostly with the therapeutics of water.

External.—The value of the local application of water to the body depends in a great part on its being a convenient means of bringing heat and cold to bear on certain affected parts. In *hæmorrhage*, for example in epistaxis, the bathing of the nose in ice-cold water is a very old method of checking the bleeding, possibly by inducing a reflex contraction of the small arterioles in the nasal mucous membrane, and for a long time one of the approved methods of treating uterine hæmorrhage was to pour cold water from a height on the abdomen over the fundus uteri—the mechanism of the arrest of hæmorrhage that occurred being explained on similar grounds—in any case the stream of water or the soaked cloth or sponge should be applied suddenly for a few moments at a time but continued in that manner

sufficiently long, otherwise a stage of reaction would lead to the dilatation of vessels and recurrence of bleeding. Epistaxis has also been arrested by placing the hands in iced water; cases were particularly recorded by Dr. Vasilieff of St. Petersburg. But in recent years the hæmostatic action of very hot water has been found more useful because more persistent. Mr. C. B. Keetley drew attention to the value of *hot* water as a hæmostatic, in a case of thigh-amputation, where a sudden drenching with water at 120° F. stopped the bleeding after cold water had failed to do so. He suggested that in such cases it acts as an excitant to the nerves of the muscular coat of the small vessels, and perhaps directly irritates the muscle itself (Pract., 1879). He has also found hot water efficacious in epistaxis, though he acknowledges that "it is powerless against it if of a certain grade of severity," and I have seen its use in a very severe case followed by serious results. During one attack the attendant had applied it for some time, though the bleeding continued, and the patient became alarmingly prostrate. I stayed the flow quickly with cold water, but in a second attack, some weeks afterwards, I heard the hot-water treatment was again employed, and the patient died of syncope.

For *uterine hæmorrhage* the effects of hot water, not poured on the abdomen, but injected directly into the bleeding cavity, have proved of the greatest value. Among those who first employed hot-water injections in this way may be mentioned Windelband, who used a temperature of 117° to 124° F. Emmet (New York) and Whitwell found them safe and efficient in *post-partum* hæmorrhage (Lancet, i., 1878). Lombe Atthill used them constantly (at 110° F.) in his practice at the Rotunda, not only in hæmorrhage, but also in chronic uterine congestions. Ricord found a hot uterine douche, 122° F., "almost infallible" in menorrhagia. C. Richter used hot douches for hæmorrhage in childbed, and reported 105 cases occurring in the Charité (Berlin), where they had been employed with excellent results; he recommended the addition of a small quantity, 1 per cent., of carbolic acid, and employed from 3 to 5 pints at a temperature of 122° F., which is perhaps rather high. He held that the hot water coming in continued contact with the inner surface of the uterus causes a soaking and swelling of the tissues, particularly of the perivascular connective tissue, and thus checks the hæmorrhage (Zeits. für Geburts. und Gynæcol.).

I have ordered hot-water injections in several cases of uterine hæmorrhage, directing a stream of 122° F. into the uterine cavity, and the effects have been various. When hæmorrhage arose from cancer, sometimes there was immediate relief, which lasted for some days, but in others the bleeding was increased; when the bleeding came from a retained portion of placenta a larger flow occurred—in such cases the retained piece of placenta should be removed; when the hæmorrhage is caused by an atonic state of the uterus, the hot-water injection alone did little good, but when alternated with cold injections, 60° to 70° F., the result was excellent. In all other cases of hæmorrhage the effect was beneficial. I am satisfied that the water should be as hot as possible, otherwise success cannot be secured; and I agree with Runge in calling it “a non-infallible but an important remedy.” Hot-water bags applied to the lower part of the spine also prove useful in uterine hæmorrhage.

Ulcers, Wounds, Contusions, etc. — The “cold-water dressing,” with wet lint cut accurately to an ulcerated surface, or amply covering an inflamed part and overlapped by oiled silk or gutta-percha, is one of the best, as it is the simplest application, for ordinary cases. In abscess, warm fomentations expedite the pointing and relieve tension, pain, and other symptoms. This action is assisted by previously painting the part with a mixture of glycerin and belladonna. They are useful in encouraging bleeding from leech-bites, etc., and in assisting the separation of sloughs. In more severe wounds, if there be much heat and irritation, it is well to keep the dressing constantly moist, uncovered by waterproof, and the most complete method of doing this is by *irrigation* from a can of water over the bed—a small stream percolating the dressings, and draining into a basin on the floor. The addition of a small quantity of carbolic acid, or some other antiseptic, to the water in all the above cases aids its action by keeping the discharge sweet. On the other hand, the cold-water treatment of wounds is sometimes too depressing, and leads to slowness of repair, or sloughing, and the hot-water dressing or immersion has been recommended in such cases, especially by Professor Hamilton (New York) and some other American surgeons. If recent lacerated or incised wounds of unhealthy character are kept constantly under hot water (95° to 100° F.), there is a sense of comfort induced, not

absolute relief from pain. On the second or third day, the parts adjacent are swollen, but not much reddened; the integument is sodden and white. On the fifth day, or later, the swelling is sometimes great, and the granulations covered with a white exudation, but the area of acute inflammation is much limited; erysipelas and gangrene are arrested or restrained; traumatic fever has seldom, and septicæmia has never occurred in any case in which submersion has been practised from the first day (New York Med. Record, 1874). Of course, simple incised wounds and healthy amputations do not need such an elaborate method of treatment.

The system of prolonged hot baths is largely practised in Vienna, where, in the General Hospital, Hebra's baths, which were originally made for the treatment of extensive burns and skin diseases, are utilised for the purpose. Patients who have had sloughing at the end of the stump after amputation, and also those suffering from chronic discharges, as in psoas abscess, are kept in a bath of warm water day and night for weeks and sometimes months together, until healthy granulation sets in. The patients soon get used to their constant immersion, and sleep well in the bath; the discharges are removed by well-arranged mechanical contrivances, and the patients thus relieved from the necessity of getting out of the bath. The healthy skin, however, acquires a peculiar sodden appearance.

Dr. Winckel, of Dresden, has adopted the warm bath continued for twenty-four hours or more in the treatment of infantile disorders; as indications for such treatment, he mentions a state of low vitality in children from the age of twenty-eight to thirty-six weeks; prostration after loss of blood; extensive cutaneous disease, and extreme emaciation from gastro-intestinal catarrh (Record, 1882).

Hot water, also hot air and radiant heat, baths are useful in the treatment of recent **sprains**, the affected limb being kept in them at the highest endurable temperature for about fifteen minutes.

For **Burns, Cellulitis, Sloughing Phagedæna and Chancres** immersion in the hot bath is efficacious, relieving pain, limiting the disease, hastening separation of the sloughs, cleansing the wound, etc.

Hernia.—A bag of pounded ice placed over a hernial protrusion has caused its reduction; the cold lessens the volume of

the contents of the gut, especially of the gases ; it also stimulates peristalsis and causes contraction of vessels.

Heat also is used for hernia by fomentation, or better, by the hot bath. It relieves pain, allays spasm of muscles, and so favours reduction : the taxis should be employed while the patient is in the hot bath, which should be continued until muscular relaxation is complete. This is a method which was formerly employed more frequently than at present, when chloroform is used to bring about muscular relaxation.

Stricture.—Retention of Urine.—A lump of ice introduced into the rectum is a good remedy for retention of urine. Immersion in a hot bath is useful in similar retention, especially when due to congestive or spasmodic stricture, or to either of these conditions added to organic stricture. The application of a hot sponge or fomentation to the genitals and hypogastrium is the simplest way of relieving “nervous” retention. The injection of cold or warm water into the rectum is often very useful, in causing the recommencement of secretion after suppression of urine.

In **Orchitis**, iced water made to circulate through a tube coiled round the affected testis will often relieve pain instantly, and entirely cut short the attack ; it should be applied early. A similar coil applied to the penis has been introduced by Dr. Otis, for the treatment of hæmorrhage from the urethra, after internal urethrotomy. “Leiter’s” tubes of metal are serviceable.

Bubo.—Hæmorrhoids.—In these maladies also the application of ice or cold water is often serviceable. At other times hot fomentation gives more relief, as it may do in orchitis. The best rule in all these cases of inflammation is to apply cold applications in an early stage, to cause, if possible, abortion of the attack. Later, cold only does harm, and warmth is indicated as being more soothing. Patients suffering from chronic hæmorrhoids often obtain great relief if they wash the anus with soap and cold water immediately after each motion. In this way irritating fæcal matter is removed and the cold produces a contraction of the blood-vessels.

Varicocele.—Suspending the scrotum in cold water night and morning braces up the dartos and the muscular tissue in the veins, and relieves this malady.

Vesical Catarrh.—Warm hip baths are of much value in this condition, and may be employed two or three times daily, for half an hour or an hour at a time. In gonorrhœal inflammations and discharges they are also good.

Catarrh.—In frequently recurrent attacks of this affection—"always catching cold"—a condition generally dependent on impaired nerve-power and over-sensitive skin, the Turkish bath proves useful; but when inadmissible for any reason, simple cold wet-towel friction in the morning should be substituted. The open-air bath, or sometimes the daily morning "tub," is also of much service in "hardening" such sufferers against cold.

Tonsillitis.—Diphtheria.—Thick compresses wrung out of cold water, applied to the throat and covered with flannel, usually give much relief, but sometimes answer better when soaked in very hot water (112° F.) and applied over the front part of the neck and chest, covered with flannel and oiled silk, and renewed every four to six hours.

In **Spasmodic Croup**, a cold wet cloth to the back of the neck and the larynx during the attack, and douching the spine or the whole body once or twice daily, is an effective treatment. The popular remedy in these cases is a hot bath; to dash cold water over the child is, however, more effectual. The essential phenomenon in this affection is a difficulty of inspiration due to tonic spasm of the adductor muscles of the larynx. The effect of cold water applied to the upper part of the body is always to produce a reflex excitation of the respiratory centre in the medulla; this is instanced in sea-bathing; when the waves reach the chest deep inspirations are produced. In laryngismus stridulus the deep inspiration produced by the cold affusion overcomes the obstruction caused by the laryngeal spasm.

Dr. Ringer recommends that children subject to this affection, and also those who suffer from "a catch in the breath," which awakes them from sleep in the night, should be sponged two or three times daily with cold water. This is best done in front of a fire in cold weather, while the little patient stands in warm water; there is then no fear of catching cold. Daily exercise in the open air acts in a bracing way, and helps to prevent the recurrence of the attacks.

Pneumonia.—Pleuritis, etc.—Niemeyer and other high au-

thorities, chiefly German, have strongly advised continuous cold applications in the early stages of both pleurisy and pneumonia, placing compresses over the affected side, and changing them frequently; they now even prefer the ice-bag in such cases. Dr. Day has recorded a case of pneumonia in a boy aged thirteen who was treated by the bath method with success, it being used sometimes oftener than once a day, in fact whenever the temperature reached 104° . The bath had a temperature of 90° , which was cooled by means of ice to 70° while the patient was in it; iced water was given freely to drink (B. M. J., ii., 1883). Professor Bozzolo has used the cold, or the gradually cooled bath with success in the treatment of this disease, and says the bath may, if necessary, be repeated every three hours. Brugnattelli states that going directly into the cold bath (70° to 66° F.) gives better results than gradual cooling—he reports eleven cases (Record, 1883). Professor Flint used in preference the wet sheet; if this makes the patient feel chilly he is wrapped in blankets until that feeling has passed off, and the sheet is then reapplied until the temperature is sufficiently reduced; he used the method when the temperature rose above 103.5° and considered it free from danger.

In children the momentary immersion in a cold bath is found useful in certain stages of inflammation of the lungs and bronchial tubes. This practice was largely employed by the late Dr. Wilson Fox in the children's wards of University College Hospital. Where death is imminent from collapse of the lung, which so readily occurs in children with chest affections, the sudden cold produces deep respiratory efforts and dilates the air vesicles again, as well as causing a fall in temperature; in a few minutes the child becomes comparatively bright, and the immersion may, if necessary, be repeated several times in the course of an attack. Dr. Lees has recorded several severe cases of pericarditis, pleurisy, and pneumonia, mostly in children, treated by the ice-bag (and salicylates) with satisfactory results (B. M. J., i., 1893). The hot bath with mustard is much more used, and I think it is more efficacious.

Inhalation of warm water vapour in bronchitis, pneumonia, croup, and many maladies of the respiratory passages, softens the mucous membrane, renders it less tense and dry, liquefies the

secretions and enables them to be more easily expectorated. The warmth also acts beneficially by relaxing the parts and dilating the blood-vessels.

Phthisis Pulmonalis.—The cold douche is used externally in phthisis, chiefly in Görbersdorf and Davos, but less now than formerly. It is only suitable for cases where the temperature of the body is normal, and the disease not actively progressing, and should be employed with the greatest care and under medical supervision. The patient is first rubbed with dry towels, and then, on being made to take a deep inspiration, is exposed to the cold douche for five seconds—by degrees the duration of the douche may be prolonged, if desirable, to forty-five or sixty seconds—immediately after, the body is dry-rubbed until the skin gets red and warm; the patient is then dressed, and active exercise, such as walking uphill, completes the process. Anæmic patients cannot bear the douche for more than five or ten seconds. This treatment promotes appetite and digestion, and renders the patient less susceptible to the injurious influences of a changeable climate.

Albuminuria.—In a clinical lecture Dr. Jaccoud has stated that the cold douche forms one of the principal points in his treatment of this complaint (*Med. Times*, i., 1885). Besides insisting on milk diet for the first month he orders a cold douche for fifteen to thirty seconds over the body and loins, followed by exercise and dry friction, and he reports excellent results from this rather hazardous treatment. The more accepted treatment both for acute and chronic nephritis includes warm-packing, vapour, hot-air, sun and radiant heat baths which induce diaphoresis, etc., eliminate waste products, relieve renal congestion and lessen dropsy.

Fevers.—The application of water to the treatment of these disorders is an important point of modern therapeutics—or rather of a revival of, and improvement upon, older ideas, for it is not wholly modern. Wright and Currie, in 1786-1796, used cold affusion—dashing several buckets of water over the patient when stripped. The latter physician records an epidemic of typhus fever affecting fifty-eight soldiers, most of them severely; fifty-six were treated by cold salt-water affusion, and all recovered; the other two, considered too weak for this treatment, were the only fatal cases. He traced an evening exacerbation, and insisted on the importance of using the

remedy during this access—or at least during a period of great heat, and not during a rigor, or during a profuse perspiration (Medical Reports on the Effects of Water, London, 1798). His method of treatment, although valuable and successful, was too harsh for ordinary use ; but soon after his observations Giannini, of Milan, advocated immersion in cold water for two to fifteen minutes in all forms of fever (especially intermittent, rheumatic, and scarlet fevers) ; he drew up judicious rules for practice, and had good success, but he objected to the use of ice (*Della natura delle febbri*, Milano, 1805). Fröhlich (1822) was one of the first to regulate his practice of cold or tepid bathing by the thermometer. Ziemssen improved upon the older methods, by his process of gently lowering the patient (with a sheet) into a bath (which should be screened while being prepared) at a temperature of about 98° F., and then gradually cooling it by addition of cold water or ice to 80° or 72° F., or even lower, according to the effect produced : this should be noted by a thermometer placed in the rectum. When a distinct reduction of the fever heat is evident (it may be in five minutes or in thirty) the patient is dried, the loin cloth removed, he is wrapped in hot blankets, and laid again in bed ; and the process may be repeated two to six times daily. The temperature of the patient continues to fall two or three degrees after he is removed from the bath ; care should be therefore taken that he is removed if cyanotic or when his temperature reaches 100-101° F., otherwise there may be danger of collapse with the onset of a subnormal temperature (*v. p. 197*). A less complete mode of attaining a similar result is by cold compresses to the trunk changed every half-hour or oftener, ice-bags to the spine and other parts, injections of iced water into the rectum, cold sponging, spraying, or the wet-sheet pack. A still milder application of cold in febrile cases is to lay the patient on a bed containing cold water, which is renewed every twenty-four hours or oftener, or through which a stream of cold water is allowed to flow continuously, or several pails of ice may be hung on cradles under the bedclothes. These abstract a large amount of heat from the patient, and are especially useful both in mild and severe cases of typhoid fever ; they do not produce the excessive lowering of temperature which cold baths and cold affusions often do. The ice cap also is useful, and acts by

abstracting heat without affecting the general or cerebral circulation (Mosso and Bergesio).

All such applications, valuable as they are, must be carefully watched: they depress the circulation, sometimes extremely, and may need, after their use, stimulants internally, and hot cloths and bottles externally, in order to relieve too cold extremities, blue lips, and tendency to collapse. Cold baths act not only by reducing the temperature in fever, and so lessening the amount of tissue-change, but also the tendency to fatty degeneration which is increased by a high temperature. Moreover, by prolonging the cardiac diastole they give more opportunity for the nutrition of the muscular tissue of the heart.

Hyperpyrexia.—According to general, though not universal experience, a rise of temperature above 108° F. is quickly fatal, and a range between 105° and 112° , which may occur in acute rheumatism, etc., has been specially termed “hyperpyrexia.” Under the systematic use of cold applications, some remarkable recoveries from this critical condition have taken place, and two cases fully reported by Dr. Wilson Fox attracted much professional attention to the subject. They were both cases of rheumatic fever with cardiac and other complications: one, a woman of forty-nine, was lowered at 9.50 P.M. into a bath at 96° , when her temperament was 109.1° F. She was unconscious, the pulse imperceptible, the face cyanotic, the respiration irregular and gasping. At 9.55 P.M. the rectal temperature was 110° . “Ice was fetched, a large lump was placed on her chest, another on her abdomen, a bag filled with ice was tied down the length of the spine, and while two assistants baled the warmer water out of the bath, two others poured ice-water, as rapidly as the pails could be filled, over the patient.” At 10.10 P.M. her temperature was 109.1° : at 10.25 P.M. it was 106° ; the pulse now became perceptible (140), and the patient showed signs of consciousness. Brandy was freely given. At 10.35 P.M. the temperature was 103.6° F., and the patient was taken out of the bath. At 10.55 the temperature was 100.6° F., lividity had disappeared, the patient could speak, and had a certain imperfect consciousness: the temperature continued to fall, till at 11.25 P.M. it was at 97.4° (vagina), and hot applications and an enema of brandy were required to prevent collapse. Another bath was given next

day, when the body-temperature had risen to $104\cdot5^{\circ}$ F.; the bath was at 64° F., and was continued for twenty minutes; on removal, the patient's temperature was $103\cdot9^{\circ}$, and it continued to fall for forty minutes longer till it reached $99\cdot4^{\circ}$. Rigors occurred, and hot applications were again required. From this time, the cold treatment was continued by ice-bags to the spine, which sometimes were effective in reducing the body-heat, and sometimes not, but within a week from the baths the patient was sitting up convalescent, and within a month was able to travel.

The second case presented more difficulties, and required a longer treatment: it occurred in a man, aged thirty-six, suffering from double pneumonia, double pleuritis, and pericardial effusion. On the seventeenth day of his disease, the temperature rising rapidly to 107° F., and delirium setting in, he was placed in a bath at 89° F., which was cooled to 86° . The after-effect of this was a fall of body-temperature to 98° , and return of consciousness. For eight days cold applications were kept up almost continuously; eight baths were given, of duration varying from twenty-five minutes to seventy minutes, and in the intervals the ice-bag or wet-pack was used, the object being to keep the temperature under 103° F. at least. This patient also made a good recovery, but the temperature did not remain normal until thirty-one days after this treatment was commenced (*Lancet*, ii., 1871).

Shortly before these cases, Dr. Meding, treating rheumatic hyperpyrexia in a female, aged twenty-two, with enemata of iced water every half-hour, and the application of iced cold cloths, reduced the temperature in five hours from $108\cdot6^{\circ}$ to $99\cdot5^{\circ}$ F., and the pulse from 140 to 72; no further rise ensued, and no relapse.

Of course, all cases have not been so successful, and Dr. Fox refers to several that ended badly; yet those quoted are sufficient to show the immense power of this mode of treatment, and it has, since that time, been endorsed by many English authorities. Dr. Anstie especially pressed its adoption, and Dr. Waters (Liverpool) has given good illustrations of its value in two cases of rheumatic fever, one with pericarditis, and both reaching a temperature of $106\cdot7^{\circ}$ F., and treated by baths at 95° to 100° , cooled to 70° , and sometimes lower (*B. M. J.*, i., 1878). Dr. Ord has given details of the use of graduated cold baths in ten cases

of hyperpyrexia, of which two were fatal (one of these had only one bath, and died eleven days afterwards of congestion of the lungs). In several of the cases, relief to nervous excitement, and even to a congestive condition of the lungs and bronchial tubes, as well as to pyrexia, was marked; six was the largest number of baths given in any one case. The only contra-indication is excessive weakness (St. Thomas's Hosp. Rep., 1879).

There is some evidence that *warm* bathing will reduce temperature, and if so, we certainly avoid some risks by it. Dr. Mackey has recorded the case of a child *æt.* two, suffering from bronchopneumonia connected with rachitis; when the temperature was 105° to 106°, a bath at 94° to 96° continued for twenty to thirty minutes always reduced the temperature four or five degrees, though the case ultimately proved fatal (Lancet, i., 1885).

Puerperal Fever.—In a striking case reported by Dr. W. S. Playfair, a sheet or towels wrung from iced water were almost constantly applied for eleven days, the patient lying on a water-bed kept cold with running water, and having an ice-cap on the head; by these means only could the temperature be kept under 105°, and eventually the patient was saved, Warburg's tincture having some share in the result (B. M. J., ii., 1877). Dr. Wiltshire has also reported cases of this disease treated by *dry* cold, *i.e.*, ice packed in bottles and tins near the patient, with temporary good result under unfavourable conditions. Mr. Knowsley Thornton has found an ice-cap, for application to the head only, very useful in keeping down the temperature after ovariotomy.

Typhoid Fever.—The use of the cold bath in this disease was revived by Dr. Brand, of Stettin. His method was much like Ziemssen's, already described, to place the patient in water of the temperature of 65° to 70° F. whenever the rectal temperature reached 102·2° F., and to keep him there ten, twenty minutes, or longer, until the temperature fell 2°. In some cases the first bath is commenced at 90° F., afterwards at 5° F. lower each time till 65° becomes the initial temperature. Some stimulant is generally given and the face bathed with cold water, which also is poured over the head at intervals; a special point is that the limbs and chest must be briskly rubbed during the immersion.

The same water may generally be used for several baths, supplying sufficient fresh hot or cold. In the Charité Hospital at Berlin, the bath, which is wheeled to the bedside, is expected to last for one day, even if used every three or four hours, as it is when the temperature is over 100-101° F.; this is, at present, the accepted routine treatment there. Professor Osler has reported favourable results from a modified form of Brand's treatment in which a tub-bath of twenty minutes at 70° F. is given every third hour if the rectal temperature be 102.5°. This "mitigates the symptoms and reduces the mortality by 6 to 8 per cent.," though he acknowledges that it is "disagreeable" (Johns Hopkins Hospital Reports, vol. v.). Liebermeister, at Basel, systematised the treatment of typhoid fever by cold or tepid baths, and his records show a lowering of mortality from 26 per cent. to 7 per cent. So soon as the disease was declared, usually about the ninth day, the treatment was commenced with a bath at 75° F. for ten minutes; this was repeated, not at a fixed time, but so often as the temperature (taken every two or three hours) rose above 103° F. Sometimes six or seven baths were given in twenty-four hours, but commonly a less number; they were sometimes continued for two or three weeks, but when they acted best an early remission of pyrexia occurred, and lasted for a long period; quinine in full doses, or digitalis, were often combined. Jürgensen followed a similar practice, and also Bartels, who claimed to reduce his mortality to 3 per cent. It may be estimated that in France and Germany the deaths have been diminished by at least one-half.

In this country the cold bath is not so largely employed; Dr. Cayley, however, has been able to show excellent results from its employment at the London Fever Hospital. The risk of movement and disturbance in cases with serious intestinal lesions has weighed heavily with English physicians against its frequent use. But in cases where a hyperpyrexial condition is present, it has often been employed with success, as a rule in the form of the *graduated* cold bath; that is, one in which the temperature is gradually lowered from 90° to 70° F. Recently a form of bath has been described which can be administered without moving the patient from bed (B. M. J., 11th Jan., 1902). For ordinary cases, more or less frequent sponging with tepid or cold water, according to the degree of fever, is grateful and sufficient; in other cases the

use of beds with a stream of cold water kept running through them as already described is an effectual method of applying the cold treatment. In severe cases, ice-packing and ice-cap may be substituted for the bath. These applications have the advantage that the patient can remain in bed during them, but are not so effectual as a bath in reducing temperature. Albuminuria or pulmonary complications do not contra-indicate bathing.

Dr. James Barr has strongly advocated prolonged immersion in a *tank bath* at a temperature of 90° to 98° F.—the higher the pyrexia, the cooler the bath; the patient is kept in the water for six to thirty days, the discharges being passed in the bath and arrangements made for renewing the water; he reports forty cases of enteric thus treated, with one death, and claims for this method all the good effects of the cold bath without the drawbacks (Lancet, i., 1891). It is however not available in ordinary practice.

Remittent Fever.—A similar method of systematic bathing has been followed with advantage in the remittent fever of the tropics, and Dr. Lucas has described a severe case in which the patient (at 103° F.) was lowered into a bath at 83°, and a small continuous stream of cold water was poured over the body for eight minutes; on the return to bed the temperature was 97° F.; quinine and port wine were given. After seven days of bathing—the temperature being kept under 103°—some bronchitis having developed, injections of cold water into the rectum were substituted for the bath, and with very definite effect in lowering temperature; recovery occurred in about a month (Med. Times, ii., 1879). In intermittent fever, both Currie and Giannini used cold affusion and bathing with excellent effect, and found that it prevented or delayed a paroxysm if given an hour before the usual onset of the attack; also that the water-treatment much assisted the action of quinine.

Scarlet Fever.—In this fever, some of the best results of cold bathing and packing have been obtained. In mild cases, tepid or cold sponging during the course of the disorder, and a few carbolised warm baths at the termination, are all that is necessary. The warm baths during the period of desquamation help the process, and give much comfort to the patient, especially if followed by inunction of carbolised oil or glycerin. They also stimulate

the action of the skin, and lessen renal congestion, or the risk of it, and also the chance of infecting other persons.

Dr. Vaudrey Lush, indeed, and some other physicians, have advocated the routine use of the warm bath from three to five minutes at first three times a day, afterwards less often, for every case of the malady (*Lancet*, ii., 1880); but without denying the advantages of this method, it is often impracticable, and cannot be considered necessary.

In very severe cases, however, when the temperature rises to 104°, 105°, or 106° F., and there is delirium or stupor, the rash being dark and indistinct, and the urine scanty and albuminous, I have seen, even in apparently hopeless conditions, the cold or hot wet-pack bring out a vivid rash, and cause lowering of temperature and abatement of all the severe symptoms. Dr. Edison has reported two illustrations of this, occurring in children, with delirium, etc., and both successfully treated by frequent bathing (*Lancet*, 1877); interesting cases treated by cold affusion, also valuable cautions on the subject may be found in Trousseau's *Clinical Lectures* (vol. ii.).

I first used the *hot pack* in a case of suppressed scarlatina (where the prejudices of parents prevented the usual cold applications), and finding the results equally good, I have commonly adopted it. In the case of a boy whom I found convulsed, and with dusky purplish skin, on the third day of what was presumed to be scarlatina, the hot sheet acted admirably. The throat was much affected, albumin was present in the urine, and consciousness was lost: within half an hour of commencing the hot pack he was able to speak, perspired freely, and the rash came out a vivid red; he was afterwards put in blankets, and went on perfectly well without the necessity of repeating the pack. In another still more severe case, the convulsions had lasted over two days, the child was quite blue, there was albumin in the urine, and his life was despaired of; but in the first pack consciousness returned, and recovery followed. Although the temperature is commonly reduced in the pack, I have known it rise 2° to 3° F. in five different patients in the cold pack, and in four others in the hot pack. At one time I thought such an occurrence to contra-indicate the treatment, but further experience has shown me that it does not do so, or interfere with recovery.

The vapour bath is another mode of effecting the same result, and is especially applicable when renal congestion and albuminuria are marked, and in such cases compresses, poultices, or fomentations should be kept applied over the loins. The instances given will suffice to show the power of this treatment, although certainly there are cases of malignant scarlet fever which no art can save.

For the *sore throat* of scarlatina, compresses should be used externally. I find it best to have the throat bathed with water as hot as can be borne, for about five minutes every three or four hours, and directly afterwards a bandage, wrung out of water at about 112° F., should be applied round the neck and covered with oiled silk. This should be continued for three or four days as an adjunct to other treatment. Dr. H. Corson (U.S.) recommends a piece of ice, in gutta-percha tissue, over each parotid gland. Cold may also be applied to the neck in this and other forms of tonsillitis, by a coil of tubing through which cold water is kept constantly flowing. Warm water is a good gargle, or ice may be swallowed in small pieces with much advantage.

In **Measles, Small-pox**, and other eruptive disorders, similar treatment by bathing and packing is valuable.

In **Erysipelas**, with a temperature of 102° F., baths at 95° or 85° cooled to 92° or 77° reduced the fever, appeared to act favourably on the nerve centres, and shortened the duration of attack, though they did not influence formation of abscess or migration of the disorder (Med. Record, 1883).

Rheumatism, etc.—I have often given the greatest relief in an ordinary but severe attack, with pain in all the joints, sweating, pyrexia, etc., by means of a hot blanket-pack, the patient being enveloped in one blanket wrung out of hot water, and then covered with several others, and thus left for half an hour or more. In *chronic* gout and rheumatism the Turkish and other forms of hot-air and radiant-heat baths are especially useful, also in rheumatoid arthritis; but the best reports by Hedley, Armstrong, Chauset and others are of the hydro-galvanic bath, which, besides improving the general health, restored mobility to the joints. With the "Tallerman" much relief is often given in chronic cases, but I have never seen absolute cure. A remedy for rheumatism, said to be very successful in India, consists of hot mustard baths, each lasting twenty minutes, followed by

application of hot flannels; this produces profuse diaphoresis, relieves the pain, and is said to lead to a speedy cure (B. M. J., i., 1883). I have often used it for a much longer period with advantage.

Neuritis, Sciatica, Lumbago and various neuralgiæ may be well treated in the same manner, but the electric bath No. 2 is especially effective, being a form of vibratory treatment which lessens the irritability of hyper-sensitive nerves (v.p., 185).

Hepatic Congestion.—In acute cases, hot packing over the liver, and in subacute and chronic cases, hot mustard-packing and a course of Turkish baths, are highly serviceable.

Appendicitis.—Peritonitis.—The application of an ice-bag, or of iced compresses, in these conditions often proves more useful than the orthodox poultice, and in early stages the local inflammation and the general pyrexial state may both be relieved by local cold. On the other hand, in some cases a prolonged hot sitz bath, or smoking-hot fomentation, renewed about every half-hour, gives great relief. The nausea or vomiting is often quickly checked by administering small quantities of ice or iced water; at other times by hot water.

Diarrhœa.—The abdominal pain of acute diarrhœa is soothed by compresses, poultices or warm bathing. In children some care is required as to the bath, for convulsions have occurred on placing a child suffering from diarrhœa in a bath at 98° F. This was most likely from an increase in body-temperature under the influence of external heat (Haddon, Pract., vol. viii.). The child ultimately recovered, but in such a case the cold sheet would probably answer better.

Cold applications are often more suitable than hot ones in choleraic diarrhœa (M'Kenna, Lancet, ii., 1876), and I agree with Messemmer in the experience that cold water enemata act excellently as tonics and astringents in chronic cases. If slowly injected, they distend and keep apart the coats of the bowel, and thus save irritation (Med. Record, 1878): I have followed this practice for many years. Wenzel, an experienced naval surgeon, recommends injections of ice cold water in dysentery, and has found recent acute cases subside quickly under this without other treatment. Fleury gives some remarkable illustrations of chronic dysentery and diarrhœa cured by the systematic use of the cold

douche externally, one patient, aged forty, having previously used many remedies under able physicians. It is certainly to be remembered in obstinate cases.

Even in cholera, the application of water, warm or cold, may be made highly serviceable. Trousseau wrote strongly in its favour when prejudice against it was greater than it is at present. The stage of collapse may be controlled by a *hot* mustard blanket-pack; but, as a rule, more permanent good will be obtained from *cold* applications. Niemeyer recommended the pack with iced sheets in cholera (*Lancet*, ii., 1876). The use of the cold sheet should be combined with friction, and under this treatment during a recent epidemic it is said that 300 cases all recovered, though under drug treatment previous cases had died. After being wrapped in a wet bath-sheet and strongly rubbed by two attendants over the whole body, a jug of cold water was poured over the sheet and the rubbing resumed till the body became warm; the patient was then rubbed with a dry sheet and the stomach being bandaged with linen and flannel, he was made to walk in the open air. This treatment was originally carried out by Schindler, the successor of Preissnitz. There is now no doubt that many of the symptoms in diarrhœa and cholera are due to the great loss of water from the body; this is shown by the beneficial effects of subcutaneous or rectal injections of normal saline solution. Cold baths may thus, apart from their general influence upon the body, have a good effect in enabling the body to absorb water.

Skin Diseases.—In all forms of dry, scaly, skin disease (whether syphilitic or not), warm baths (especially when made emollient and alkaline), vapour and radiant-heat baths are useful. In acne, hot bathing or steaming opens up the glands and relieves congestion. In psoriasis, ichthyosis, lichen, prurigo, pityriasis rubra, chronic dry eczema and seborrhœa, for removing accumulated secretion or preventing contact of air, water compresses are serviceable. Hebra has tried the prolonged warm bath for from *two hours to nine months* at a time, in such cases and in extensive burns, and has ascertained that nutrition, respiration, and secretion go on in the continued bath in a normal manner. On the other hand, in some skins, and especially when the epidermis is removed, as it commonly is in acute eczema, water is apt to excite much irritation. For this reason normal saline solution,

0·9 per cent. sodium chloride in tap water, should be used. As a general rule, simple water, even for washing, should never be allowed to touch an eczema which is discharging. Cold weak gruel, or milk and water, are to be substituted for it. Water always acts destructively on protoplasmic structures such as the Malpighian layer of the skin.

A course of warm baths, two daily with occasional vapour baths, proved effective in an aggravated case of obesity, which diet had failed to influence (Med. Record, 1885), and when these have been too exhausting I have found the radiant-heat bath answer better.

The Action of Hot Baths in Syphilis.—The effect of balneo-therapeutic, simultaneously with mercurial treatment, has generally been regarded as beneficial in many cases of syphilis. Dr. M. Ussass, of St. Petersburg, has endeavoured to throw light on the action of hot baths—sulphurous and other—in this affection by studying the results of the local application of heat. He used very hot foot-baths, applied so as to come up to the knees, while the temperature of the water—108·5° F. to commence with—was in three to seven minutes gradually increased until 113°, and sometimes even 117·5° was obtained. The temperature of the bath ought not, he found, to be raised after the patient's pulse-rate reached 112 beats in the minute. When this treatment was carried out before the appearance of secondary symptoms, the general eruption was, he says, always less marked, so far as could be judged by comparison with patients not treated in the same way. Moreover, if the treatment were commenced before the lymphatic glands were affected, and especially if the primary sore were likewise locally treated by heat, the glands seemed to remain unaffected, or became only slightly enlarged, and the general eruption was delayed, so that it appeared only after six months or even not till the end of a year. Secondary symptoms could not, however, be altogether prevented by these means. This work of Ussass, together with several recent Russian articles on the same subject, are discussed by Dr. A. Dworetzky, of Kreutzburg, Russia, in an interesting communication to the *Zeitsch. für diät. und physik. Therapie* (1900, vol. iv.).

Cerebral Congestion.—Cold applied to the head, whilst hot mustard-water is used to the feet, is one of the simplest modes of equalising the cerebral circulation. It must, however, be used

with caution where cerebral anæmia is readily induced, as in weakly subjects. Ice to the nape of the neck also acts well, and sometimes the *alternate* use of cold and hot applications gives the best results. This is especially the case in the congestion of opium-narcosis, uræmia, and carbonic acid poisoning.

Meningitis.—In cerebral or spinal meningitis the application of ice is a valuable resource, but if the face be pale, and there be tendency to chilliness and prostration, it is not suitable.

Sunstroke.—"Thermic Fever."—When the head is hot, the pupils contracted, the pulse full, and the temperature high, cold packing is decidedly indicated, also cold affusions, especially to the head. Rectal injections of cold water may also be given with advantage, especially when the temperature is very high and the patient is unconscious.

Delirium Tremens.—When the symptoms are violent and acute, with flushing and heat of head, full pulse, and much restlessness, a cold pack, or, if possible, a douche, or at least an ice-bag or cold compresses to the head, may be very useful in procuring quiet, and even sleep. When much depression or evidence of vascular degeneration exists, such treatment must be employed with extra care.

Insomnia.—This is often amenable to different applications of water. The general tepid bath is especially suitable for children. A cold sitz bath relieves after intellectual work, or even a cold compress of a folded wet towel placed on the epigastrium, and covered by a dry towel, is often efficacious. A hot mustard foot bath, whilst cold is applied to the head, or a rapid dipping of the feet in cold water and vigorous friction afterwards, tend to the same result.

Mental Disorder.—**Melancholia.**—So valuable is the douche bath in some mental cases that there has been a tendency to overdo this form of treatment, and even fatal results have been recorded from it in cases of extreme depression. It is important not to use it too long at a time. Ten to twenty seconds is sufficient for melancholic cases, and the patient should stand in warm water, so as to secure warmth of the extremities. One or two minutes of a shower bath should suffice for excited cases, and often a prolonged warm bath (thirty minutes), whilst cold is applied to the head, is the most soothing form of treatment. The

Turkish and "light" baths have now been introduced into asylums, and with excellent results.

Hypochondriasis.—A course of cold-water treatment, which is at first stimulating and afterwards soothing, is useful in this affection. It generally stimulates the vital functions, promotes tissue-change and nutrition, invigorates the skin, and strengthens the physical and mental condition. Other kinds of treatment, however, are often more successful.

Impotence.—When this arises from excess, cold sitz baths and spinal washings often relieve.

Convulsion.—The reflex convulsions of infancy are often cut short by a warm bath, cold water being poured on the head at the same time. Hysterical convulsion is sometimes arrested by a sudden shock of cold to the surface, and a daily shower bath is of great service in improving the hysterical state.

In **Chorea** cold affusion, especially over the spine, is very beneficial, and I have had excellent results from the shower bath.

In **Uræmic Convulsion** this treatment is not so markedly effective, though cold to the head is advisable; but the use of packing, or of the vapour bath, as soon as the general condition admits, is often of the greatest service. Dr. Ransome recorded a case of puerperal eclampsia, in which the patient was wrapped in the warm wet sheet for six hours. Free sweating was produced, the convulsions ceased, and next day the urine was free from albumin, and the patient made a good recovery (B. M. J., 1883).

Paraplegia.—In cases connected with functional disorder of the cord, hot or alternate hot and cold douches to the spine often act well. Paralysed limbs that have become cold and wasted may often be much improved by towel-packing and douches, combined with vigorous friction.

Spinal Pain.—The sense of weakness and exhaustion referred especially to the lower part of the spine, occurring in delicate subjects after over-exertion of any kind, is much relieved by cold "spinal washings," or gentle douching each day for a short time, and followed by good friction. Dr. Moxon drew attention to the comparatively feeble circulation in the lower part of the cord, and doubtless such remedies act by quickening and regulating the blood-current in that part (B. M. J., i., 1881).

The more acute backache, commonly felt by women, and in the absence of definite cause often assumed to be due to "anæmia of the cord," is better relieved by hot applications; and if the douche be not obtainable, then a hot sponge or fomentation will serve.

THERAPEUTICAL ACTION.—*Internal.*—Preissnitz and his early followers combined with the outward application of cold water its immoderate and excessive use internally, an error which is now not often repeated. Water-drinking is ordered on general dietetic principles, especially as a solvent and diluent, rather than as an essential part of a hydropathic course.

In **Fevers** of all kinds and in **Diabetes** it is used to lessen thirst, to lower temperature, and restore the balance of fluid constituents of the tissues; also to promote secretion and the elimination of waste products.

In **Cholera** most authorities consider it dangerous to give cold water, and think it better to relieve the intense thirst by giving ice to suck. Surgeon-Major Pringle has stated, however, that iced drinks are dangerous, and that water of the temperature of the air is best adapted for the relief of thirst, and tepid water for the prevention of retching (B. M. J., ii., 1885).

Nephritis.—A copious supply of pure water is an effective non-irritant diuretic, and is very useful in acute renal congestion and inflammation, washing out the epithelium and casts from the obstructed tubules. It renders more soluble, and helps to carry off waste products, and the good effect of many infusions and decoctions is doubtless largely due to the amount of water they contain. Its diuretic effect is chiefly due to the increased blood pressure it produces throughout the body, including the kidneys.

Constipation.—A glass of cold water taken, fasting, in the early morning, will assist in securing a regular action of the bowels; if taken also the last thing at night it has a still better effect; it acts by stimulating peristaltic action, and by passing fluid more rapidly down the alimentary canal so that the fæcal contents are diluted. Hot water, on the other hand, often tends to constipate.

Hæmorrhoids.—Plentiful water-drinking is indicated in this disorder, but a course of aperient *mineral* waters is more effective.

Chronic Metallic Poisoning.—In some cases of this kind the taking of a large quantity of water is useful by aiding solution

of minerals deposited in the tissues, *e.g.*, antimony, arsenic, lead, copper, mercury, etc., or rather their mechanical removal by disintegration of cells. If, however, anæmia be marked, as it often is, this method must be used with care, for fear of impairing nutrition.

Syphilis.—In the later stages of syphilis, or when relapses are frequent, and mercury or iodides are not well borne, hydropathic treatment is a useful resource, tissue-change being promoted by free water-drinking, but a course of baths is the most important element in such treatment.

Gout.—Gravel.—In these cases, hydrotherapy will improve the general condition, and sometimes, it is said, disperse concretions; it promotes tissue-change, as shown by increase of urea, and the water dissolves uric acid and other urinary constituents; it will not, however, produce the marvellous cures sometimes expected of it.

Water dilutes the urine, and renders it less irritating in pyelitis, cystitis, gonorrhœa, and other affections of the genito-urinary tract. It is generally given in such cases in the form of aerated waters or mucilaginous drinks.

The dietetic use of *hot water* in gout has been recommended, one or two tumblerfuls of water at 120° being given in the early morning; this is said to regulate the bowels, to cause the disappearance of uric acid and lithates, and to diminish the frequency of acute attacks (Weber). Cadet de Vaux (1825) carried this idea to an extravagant pitch, ordering 8 oz. of hot water (120° to 140° F.) every quarter of an hour for twelve hours.

What is known as the “Salisbury plan” for the reduction of obesity, and the treatment, not only of gout and rheumatism, but of fibroid and ovarian tumours, diabetes, and even phthisis, comprises the drinking of a pint of hot water at about 110° F., from one and a half to two hours before each meal, and half an hour before retiring: the hours given as the best for drinking are six and eleven A.M., four and nine P.M. From five to fifteen minutes should be taken for drinking the water, so as not to distend the stomach to an uncomfortable degree. The object of the hot water is “to wash from the stomach the slimy mucus, alcoholic and sour yeasts and bile before eating and sleeping”; and there should be time for it to get out of the stomach before the food enters. At

meals, one cup of tea or coffee is allowed in addition. Conjoined with this is the living almost entirely upon the "muscle-pulp" of beef broiled, and some other meats and fish. Aperients are generally needed under this regimen, especially at the commencement.

Gastric Catarrh.—In this affection the habitual drinking, especially in the early morning, of large quantities of water causes the upper layer of cells in the gastric mucous membrane to swell up, die, and regenerate more rapidly than they would otherwise do. They are replaced by others with higher vitality, and under proper dietetic management the whole gastric mucous membrane becomes healthier.

Enemata.—Large enemata of warm water (1 to 3 pints) are used to clear out the lower intestine. Small enemata of cold water are often useful in habitual constipation.

SEA-BATHING.

In sea water the more important saline constituents are the chlorides of sodium and magnesium, and the sulphate and carbonate of lime; iodides and bromides are contained in minute quantity. Hence the effect of sea-bathing upon the skin and its peripheral nerves is more *stimulating* than that of ordinary water, an effect which is much heightened by the stroke of the waves.

The incoming wave beats more upon the upper part of the person, the receding wave upon the lower extremities, providing one of the best forms of douche bath for such as are strong enough to bear it. Water in motion always feels colder than water of the same temperature which is still; a cold bath, such as is usually taken, may feel so cold if the water is in motion as to be unendurable for more than a very short time; it is thus more bracing, though it may have too powerful an effect for delicate persons.

This wave-stroke is naturally more effective in some seas and on some coasts than on others. In the German Ocean (east coast of England) and in the Atlantic (south coast) it is much stronger than in the Baltic or the Mediterranean, and bathing at Cannes, for instance, is not to be compared in bracing effect with bathing at Brighton. The stimulating effect of the waves is aided by the friction of the sand against the skin, and by the active exercise,

jumping or swimming, which all sea-bathers take while in the water.

The temperature of the water is an important point in estimating the effect of any form of bath. The temperature of the sea varies less throughout the year than that of rivers: it is highest in the Mediterranean (72° to 80° F.), lowest in the Baltic (60° to 62° F.), and intermediate in the Atlantic (68° to 73° F.). It is higher in autumn than in summer. The temperature of the water is often as much as 12° F. higher than that of the air, and at midday it is several degrees higher than in the early morning.

In considering the influence of sea water, that of *sea air* must not be wholly omitted. It contains more ozone, more moisture, and more salt than inland air, with less carbonic acid, and usually less dust and foreign admixture; in fine weather the air is more clear and the sunlight more powerful at the coast than inland, and the current of the air is usually stronger and more bracing.

PHYSIOLOGICAL ACTION.—On entering the water, under ordinary conditions, a sense of cold is felt; the skin becomes pale and roughened (goose-skin), the circulation depressed, and the respiration more or less spasmodic; when the water reaches the chest, strong inspirations are brought about reflexly; in suitable subjects the temporary depression is quickly followed by reaction—the skin reddens, the pulse rises and becomes more forcible, whilst exhilaration and a sense of increased vigour indicate the stimulation of the nervous system. If the bather avoid overtaxing his powers, and will leave the water before this period of stimulation is passed, he will probably retain for several hours a feeling of improved health and general well-being, and it is to such cases that the following statement of physiological results will apply.

Tissue-change is promoted, as shown by an increased excretion of urea and sulphuric acid (Beneke); not that these are immediately or inordinately increased, but the natural healthy maximum is kept up for a longer time than usual. Appetite and digestion are certainly promoted; but if only such a measured amount of food be taken as suffices to maintain the body-weight at a fixed point under ordinary circumstances, *loss* of weight is

experienced owing to the increased tissue-change, while if the quantity of food be *increased in proportion* to the improved appetite and digestion, the body-weight is decidedly *increased* by a course of sea-bathing.

The secretion of the skin, though at first checked, is afterwards promoted: the effect of the first contraction of the cutaneous capillaries is sometimes, if the water be very cold, to determine blood to internal organs, and hence some congestion of the kidneys may occur, and a trace of albumin may be found in the urine; but this condition soon passes off, and the albumin does not persist long after the bath.

The urinary water is increased at the time, though it is said that the day's *total* quantity is rather less than normal. The intestinal excretion is usually lessened, but sometimes increased (Beneke), and either constipation or diarrhœa may be induced.

Restlessness and sleeplessness are more serious symptoms occasionally caused, but in my experience as much by a residence on the *sea-level* as by simple bathing. The hot, strongly saline baths, as at Droitwich, do, however, often induce an extreme degree of restlessness, and should not be used too frequently.

It is worth noting that the long hair of women, when often soaked with salt water, may fall off, but it quickly grows again.

THERAPEUTICAL ACTION.—Sea-bathing tends to “harden the skin,” to moderate undue perspiration, and to diminish the tendency to catching cold and to rheumatic attacks. It acts as a general stimulant in all conditions of constitutional debility, and also as a local stimulant, promoting absorption and improving circulation.

In **Chronic Forms of Nervous Disorder** with depression, and hypochondriasis, sea-bathing is often very beneficial through a strongly stimulant action on the peripheral cutaneous nerves: by its influence on tissue-change it is said to benefit, not only in functional disorder, but even after material change in the nerve-substance (Husemann).

Tuberculosis.—In various forms of tuberculosis sea baths are indicated, and during convalescence from fevers and other acute disorders, or after prolonged town-residence or town-work, they have an excellent effect.

Sprains, etc.—As a remedy for the effects of sprain or of injury to joints, or of spinal weakness, douches of hot and cold sea water are exceedingly useful.

Gargles of the same are said to have proved curative in chronic relaxed conditions of the throat, "Clergyman's sore throat," etc. (B. M. J., ii., 1879).

Time of Bathing.—To bathe before breakfast is the custom of some robust persons, but is never free from risk, and sometimes seriously injures weakly subjects: for after the long fast of night the circulatory and central nervous organs are more liable to depression from sudden shock or overfatigue. On the other hand, to bathe soon after a meal arrests the process of digestion, and may give rise to unpleasant gastric and cerebral symptoms. The best results are obtained from bathing two or three hours after the early morning meal, when the stomach is nearly empty, and there should be at least a brief interval of rest or of but moderate exercise, according to the weather, between the bath and the following meal. The object aimed at being a marked and prolonged reaction, this is best obtained from a bath taken during a condition of the greatest nutritive and functional activity, when the work of the stomach is over and the blood is enriched by the products of digestion. Sometimes it is advisable that those not in robust health should take some light refreshment shortly before bathing.

Errors in Bathing.—The good effects already described as proper to sea-bathing may be missed and unpleasant symptoms may arise if attention be not given to certain points.

The therapeutical object is to secure and sustain a good *reaction*, and this is impaired if the bath be too cold, or too prolonged, or if excessive exertion be taken before, during, or after it, or if the patient be under the influence of strong emotion, as a nervous, frightened child would be. The most common errors are to prolong the bath unduly and to exert oneself overmuch during it; the sense of vigour is then replaced by exhaustion, the skin again becomes cold, and the circulation depressed; giddiness and headache occur from altered conditions of the circulation, with general malaise, and possibly shivering, nausea, sickness, and a sense of depression lasting for many hours. It is therefore important to leave the bath before the stage of reaction and stimu-

lation is finished. With some persons the stroke of three or four good waves is sufficient for the best results, five minutes is an average time for the delicate to remain in the water, and no one bathing for *health only* should remain in the open sea for more than ten minutes. Another question which often arises is, Should one enter the bath head first or feet first? Experienced bathers prefer to dive, and state that the good effects of a bath so begun are more marked and last longer. If one enters the sea by walking into it, which is the usual practice, it is most unwise to stand hesitatingly with only the lower part of the body immersed, and then to advance timidly into deeper water. Such a proceeding may give cold, and produce a feeling of shivering and misery. Water deep enough to cover the whole body should be reached quickly and the head dipped as soon as possible. Almost immediately the head is dipped reaction begins. Many people suffer from troublesome headache from neglecting this precaution.

Contra-indications.—At the extremes of life sea-bathing in the open should be practised cautiously. As a rule, it is unsuited for children under two years of age, or for patients much over sixty. Pregnancy in healthy subjects need not prevent the use of salt baths, or sea-bathing, provided that the patient is accustomed to a cold bath previously, but, as a rule, the various inconveniences of open-air bathing render its risks greater than any advantage in that state. The tendency to cause congestion, more or less temporary, of internal organs, the brain, liver, lungs and kidneys, renders open-air sea-bathing unsuitable for persons disposed to such disorders, or suffering from structural change or a sluggish circulation within the abdominal organs, albuminuria, serious cardiac disease, chronic pneumonic infiltrations, hæmoptysis, fatty degeneration, or rheumatism which is at all acute. An extreme degree of anæmia is also a contra-indication.

MEDICATED BATHS.

Artificial Sea Bath.—“Sea salt,” such as Tidman’s or Brill’s, may be added to an ordinary water bath. The effect produced is more stimulating than that of the plain cold bath, but less so than bathing in the sea, because the splash of the waves and various other concomitants of the actual sea bath are wanting.

Acid Bath.—(V. Nitro-hydrochloric Acid.)

Alkaline Bath.—A drachm or less of sodium carbonate is added to each gallon of water. Half the quantity of potassium carbonate may be used with half of soda; or borax is sometimes preferred to either. It is useful in chronic skin diseases; it allays itching, and in psoriasis hastens the separation of the scales.

Sulphur Bath.—(v. Sulphur, p. 44.)

Mustard Bath.—Half to one drachm of mustard is added to each gallon of hot water. Such a bath is a powerful stimulant and rubefacient and, to some extent, soporific: it may be used also to quicken the appearance of the rash in acute exanthemata, —but depression may come on if the bath is prolonged over ten minutes. A hot foot bath of mustard and water before going to bed, followed by friction of the feet with a rough towel, is an old-fashioned and often effective remedy in cutting short a threatened cold in the head.

Pine Bath.—One minim of the oleum pini, or a specially prepared pine extract, may be added to the gallon of water; a less convenient method is to add decoction of pine shoots. These baths are used in rheumatism, gout, neurasthenic and tuberculous conditions.

Carbolic Bath.—A bath of weak carbolic acid (1 part in 80) is an excellent detergent and disinfectant. Medical men, nurses and others who have attended infectious (especially puerperal) cases, have found such baths excellent safeguards against propagating the disease.

Permanganate of Potassium Baths (one pound to 30 gallons of water) have been found extremely useful in cases of chronic psoriasis (Murrell).

The **Bran Bath** is prepared by boiling four pounds of bran in one gallon of water, straining and adding sufficient water; this is used to soften more stimulating baths and to soothe skin irritation. Oatmeal or gelatin may be used for the same purpose.

The **Conium** or sedative bath is made by putting three handfuls of the leaves into a full-length bath of hot water, and is useful in conditions accompanied by much itching. The vapour may be kept from the head by a suitable covering.

Aromatic Baths are prepared by adding decoction of lavender, hyssop, etc., and are useful in some forms of hysteria and nervous disorders.

The so-called **Ozone Baths** are given with a strong decoction of sea-weed (sea-wrack) for rheumatism, etc.

Mineral Waters and Baths.—These are waters containing such an amount of salts or gases in solution that they can be used for therapeutical purposes. In some cases the action depends very largely on their temperature. The saline constituents are chlorides of sodium, potassium, magnesium, lithium, calcium, and sometimes traces of iodides and bromides; carbonates and bicarbonates of sodium, lithium, calcium, magnesium and iron, sulphates and phosphates of the same metals, and sulphides of sodium and calcium. Traces of manganese, silica, arsenic, and nitrates are occasionally present. The gases are chiefly carbonic acid and sulphuretted, sometimes carburetted, hydrogen, while oxygen and nitrogen from the atmosphere are always present.

These bodies are derived from the soils through which the waters pass, they are present in very different amount in different springs, and their absolute or relative quantity determines largely the actions and uses of individual waters.

PHYSIOLOGICAL ACTION.—Their action is the sum of that of their constituents, namely water, salts, and gases. Applied *externally* in the various forms of bath, they act like the plain water baths already described, with special powers of stimulating the skin, and indirectly the visceral circulation, or of quickening absorption and lessening pain.

Given *internally*, they act by promoting tissue-change, secretion and excretion, and by diluting and depurating the blood.

THERAPEUTICAL ACTION.—Mineral waters are mainly used in *chronic* functional disorders, and in conditions of debility and convalescence, but are often beneficial also in the early stages of organic disease. In estimating their effects, allowance must be made for the change of climate and surroundings, and the more regular, simple, and quiet life of a spa; hence the drinking of imported waters at home will not give the same result as taking them at their source. Artificial waters made in imitation of the natural never give such good results.

Season.—The usual season for drinking mineral waters in-

cludes summer and autumn, *i.e.*, extends from May or June to September or October, and the duration of a course is from three to six weeks. Too prolonged treatment is liable to do harm.

Dose and Mode of Administration.—It must be recognised that benefit is not derived in proportion to the quantity of water taken : at first only small quantities daily are desirable. Bathing and drinking should not usually be commenced on the same day. When the strength permits, early rising is advisable, so that the water may be taken before breakfast ; it should be sipped slowly, and an interval allowed for a gentle walk between each glass. At certain spas it is the custom for invalids to drink eight, ten, or more glasses of water in the course of the morning promenade—but usually two or three glasses produce the desired effect equally well. The diet should be carefully regulated—it is less generous abroad than in this country. As a rule, some physician resident at the spa should be consulted.

CLASSIFICATION OF MINERAL WATERS, ETC.

Mineral waters are classified differently by different authors, but usually with direct reference to their chief ingredients.

Class 1.—Carbonic Acid Waters comprise many of various character, more or less impregnated with this gas, which renders them easier of absorption, and *chemically* assists the solution of bicarbonates, *e.g.*, of sodium and iron. Their *medicinal* properties are, to lessen gastric irritability, to stimulate slightly the secretions of the stomach and of the kidneys, and to increase the peristaltic action of the intestines. It is scarcely necessary to make a separate class under this heading, but it may be taken to include most of the natural table waters, such as Apollinaris, Gerolstein, Gieshübel, Kronthal, Johannis, Rosbach, etc. These might be placed also under alkaline or soda waters, though feebly mineralised.

The Johannis Spring obtained from borings in the rock at Zollhaus, Nassau, has all the appearance of boiling water—so great is the amount of carbonic acid gas constantly escaping : its odour is perceptible, and a lighted match placed over the water is extinguished : the analysis of the gas gives 98.98 per cent. of pure carbonic acid, and besides aerating the water, sufficient is

given off to fill steel cylinders, when it is liquefied for export. Some iron contained in this water is precipitated before bottling.

Several iron springs used for drinking are rendered more stimulating by the gas, *e.g.*, the Sauerwasser of Tarasp-Schuls, and in varying degrees those of Amphion, Bocklet, Cudowa, Pyrmont, and Rippoldsau. Much importance is attached to the locally stimulating effect of bubbles of the gas contained, *e.g.*, in the iron baths at Spa and Schwalbach, St. Moritz and Franzensbad, Marienbad and at Kissingen. At this last are baths of the gas itself conducted from the waters into a deep chamber with arrangements for it to cover the body, but not to reach the mouth. At the saline baths, also of Rehme and of Nauheim, the effect is held to be much increased by the amount of carbonic acid contained in them, and chemical compounds to produce it are added to such baths when prepared artificially. The effect is mainly a mechanical one, and it is not likely that the gas is absorbed by the skin.

Class 2.—The “Indifferent” or Simple Waters contain but small quantities of solids and so cannot be credited with active chemical powers, but they are pure and transparent, of varying temperature up to 150° F., and some contain a more than average amount of gas, either oxygen or nitrogen. Many of them are “Wildbäder,” in “wild” scenery. They act as diluents by increasing the secretions, as eliminants in toxæmia, neuritis, rheumatism and gout, for which they are mainly used in baths more or less prolonged. In this form they are often of service in neuralgia and in excitable nerve and skin conditions. They include Buxton, Bath, Teplitz, Plombières, etc.

Class 3.—Alkaline Waters, including (*a*) simple alkaline or soda, containing mainly sodic carbonate, such as Vichy; (*b*) muriated alkaline or soda waters, containing also a good percentage of chloride—such as Ems; (*c*) sulphated alkaline or soda waters containing effective doses of sulphate, such as Carlsbad. They are all used in various forms of dyspepsia, liver disorder, gout, glycosuria, etc., the salted ones being less depressing, less thinning than the simple alkaline, and are indicated specially in respiratory catarrhs, whilst the sulphated ones are for gastro-intestinal catarrh, abdominal plethora, gall stone, obesity, etc. Many of this class contain also carbonic acid.

Class 4.—Bitter or “Purging Saline” Waters, otherwise

known as sulphated or muriated sulphated, contain purgative doses of the sulphates of magnesium and sodium, the former being the "bitter" element, as in Friedrichshall, and less marked in others, such as Apenta; Brides Salins represents the muriated group.

One or two wineglassfuls of these waters (preferably taken warm) act as mild saline purgatives. They are useful in habitual constipation, but if given too frequently, or in excessive dose, they are apt in delicate subjects to bring on flatulence, dyspepsia, or intestinal catarrh.

Class 5.—Common Salt Waters contain sodium chloride as their *chief* constituent, along with other chlorides of alkalies or alkaline earths, hence "muriated" or "muriated saline" would be a better descriptive title. Small quantities of bromides and iodides are also commonly present, and often free carbonic acid.

This important class includes many of the best-known spas, Homburg, Kissingen, Wiesbaden, etc., where the waters in moderate quantity are of benefit in dyspepsia and gastric and intestinal catarrh; also in constipation and for hæmorrhoids and venous stasis occurring in thin depressed subjects; also in bone disease and tuberculous exudations, inflammatory effusions, and fibroid tumours.

Strong salt springs (Droitwich, Hall, Ischl, Nauheim, Salsomaggiore, etc.) are used as baths.

Class 6.—Chalybeate Waters contain iron in therapeutical doses, usually in the form of bicarbonate, as at Spa and Pyrmont, but sometimes as sulphate (Flitwick) when alum is often conjoined, or as chloride (Harrogate).

These waters are used in chlorosis, anæmia, irregularities of menstruation, atonic conditions of the stomach and intestine, in general debility, and in various neuroses. Care is required to secure their due absorption without dyspepsia. The general rules for iron medication are further indicated in the chapter on that remedy.

Class 7.—Arsenical Waters.—It is useful therapeutically to classify these waters apart as Weber does, though previously they have been included either under chalybeates, as Levico, or alkalines as Mont Dore or Vals. Some of them have a special repute in asthma and respiratory disorders, others in anæmia or cachexia

where iron alone does not help, or even irritates, especially in early tuberculous cases and chronic skin affections and malarial sequelæ.

Class 8.—Sulphur Waters, containing alkaline and earthy sulphides or sulphuretted hydrogen, are either weakly mineralised but hot, as at Aix, or strong, as at Schinznach, and their effects vary somewhat accordingly. They are used for chronic cutaneous syphilitic and tuberculous disorders, bronchial catarrh and phthisis, chronic hepatic congestion, chronic rheumatism, gout and metallic poisoning, such as from lead or mercury. The digestive powers are liable to be taxed by a course of these waters, and anæmia is apt to follow. Good meat diet is desirable whilst sulphur is being taken.

Class 9.—Earthy (calcareous) Waters are either feebly mineralised, as at Loèche (Leukerbad) and Bath, and may be classed with “indifferent” waters, or strong with bicarbonates of calcium and magnesium, as at Wildungen, Marienbad (Rudolfsquelle), or with the addition of sulphate as at Contrexéville and Vittel. The former are used for prolonged bathing, the latter for drinking in cases of vesical catarrh and uric acid concretions, in gouty and scrofulous exudations and skin diseases, also in bronchial catarrh and phthisis. Separate classes are made by some authors, *e.g.*, of the *iodo-bromated* waters at Kreuznach and Woodhall, the *iodo-sulphates* of Krankenheil-Tölz, and the *muriated lithia* waters of Baden-Baden, and of course separate springs at the various resorts might be referred to several of the classes above indicated. These will be found, however, to give a sufficient general idea for practical purposes, and a more detailed though brief account of the principal spas is subjoined in the same order.

CLASS 2.—SIMPLE OR “INDIFFERENT” THERMÆ.

Baths without evident active chemical ingredients are the following:—

Buxton, one of the principal English health resorts, is beautifully situated at the foot and on the slope of a limestone mountain-range in the Derbyshire Peak district, about 1,000 feet above the sea. The air is pure and bracing, but the climate is subject to sudden variations and the rainfall is rather large.

It is resorted to all the year, but June is early enough for a

pleasant visit, for there are cold winds in the spring as well as in late autumn and winter. The tepid waters which are soft, limpid and free from taste or odour, contain about 3 grains of calcium bicarbonate, and half that amount of the same salt of magnesium in the quart, with fractions of a grain of iron and of alkaline sulphates and chlorides; but it is remarkable that of the 2 cubic inches of gas contained, 99 per cent. is nitrogen (with a little argon and helium), and 1 per cent. carbonic acid with traces of oxygen. Until recently little if any therapeutic importance had been attached to this, although Dr. G. Bennett considered that it might account for the giddiness and faintness sometimes felt in the baths, if not for the more serious and even fatal results he has known to occur from their incautious use, but in 1897 A. Robin and E. Duhourcau maintained that the nitrogen might be an active agent in the good derived from the waters, and more recently (Lancet, 1900) Mr. Armstrong has published interesting observations on 300 cases which tend to prove the same. Of these patients ten were healthy, and the others suffering from gout in some form; they either drank 24 ounces daily (in three doses), or bathed or did both with the water at its *normal* temperature of 82° F., and also *above* and *below* that limit, and then the twenty-four hours' secretion of urine was measured and tested and compared; it was found (1) that the excretion of uric acid and flow of urine were both largely increased by drinking and by immersion; (2) that the uric acid excretion was augmented more by bathing than drinking, but diuresis more promoted by the latter; (3) that any deviation from the normal temperature either by heating or cooling interfered with its efficacy, which points to its dependence on the contained gas, since the salts would not be affected by changes in temperature. However some value may be attached also to the lime salts as promoting uric acid excretion.

The water is usually drunk at the spring in doses of 4 to 10 ounces; the baths at 82° F. are taken for four to seven minutes, or for the weakly with deficient reaction are heated from 86° to 100° F., and used for double that time; gentle exercise is advised after. Employed suitably they are exhilarating, but taken too often or too long they may cause chilliness, discomfort and oppression. Half or three-quarters bath is sometimes ordered,

as the full warm bath may produce drowsiness. Douches, chair, plunge and massage baths are available, also Nauheim treatment and the terrain cure of Oertel.

In attacks of acute gout or rheumatism the thermal water is ordered in large amount, to the production of profuse perspiration and sometimes of a rash which is followed by subsidence of the symptoms, but the chronic forms of these disorders with stiffness of joints and debility form the larger portion of the *clientèle* at Buxton.

Armstrong has also published remarkable cases of rheumatoid arthritis improving there—although other treatment was needed besides the waters. Different forms of paralysis, early scleroses, mercurial and lead poisonings, neuralgia, sciatica and lumbago, also sprains and muscular contractions are often benefited. It is unsuitable for acute inflammatory hæmorrhagic or aneurismal cases, and for advanced valvular or tubercular disease.

Matlock Bath also in Derbyshire, with cooler waters (68° F.) which contain small proportions of calcium carbonate and magnesian sulphate, is also well situated, but more in a valley (300 feet altitude), and is commonly found more relaxing. Many hydro-pathic establishments, for which it is a centre, are now on the higher ground (450 feet); the waters are applied in all forms of bath, and are used much as at Buxton, mainly in rheumatism, gout and their sequelæ, also in dyspepsia and debility.

Bakewell (Badequelle) and Stoney Middleton, in the same district, have similar waters.

Bath, Somersetshire.—Bath, *the Bath*, like the Badens of the continent, has been frequented for its waters for 1,800 years; they much resemble those of Buxton, but are hotter—being in fact the only hot springs in this country: the temperature of the Cross Bath is 104° F., of the King's 117° F., and of the hot spring 120° F. They contain small amounts—not more than 10 gr. in the pound of solids—sulphates of calcium, sodium, potassium, chlorides of magnesium and sodium and a little calcic carbonate, also silica, a very little iron and arsenic ($\frac{1}{200}$ gr. to the gallon), much nitrogen with traces of argon, helium and other gases. As drawn from the springs, the water is colourless and sparkling, free from odour and slightly metallic, not disagreeable to taste. From a half to two tumblerfuls of it at about 117° F. are generally taken once or twice

daily, with the usual effect of slightly raising temperature, quickening circulation and appetite, and promoting secretion; sometimes, however, headache, depression and pyrexia occur. Aerated under pressure with carbonic acid it is used as a table-water—Aqua Solis or Sulis. The bathing and other accommodation is now very good, including besides swimming and deep chair-baths all forms of douche, as at Vichy, Aix-les-Bains and Nauheim treatments, sulphur, pine and “sool” baths, the Berthollet natural vapour, inhalation and pulverisation rooms, etc. It is available the whole year, but the greater number of visitors go between November and April, for the climate is relaxing in the summer; at other times it is mild and equable, more bracing on the hills which surround the valley of the city. Cases of gout and rheumatism of moderate severity, neuralgia and myalgia, sciatica, rheumatoid arthritis, effects of wounds, contracted joints, etc., some forms of dyspepsia, rheumatic or metallic palsies, leucorrhœa, dysmenorrhœa, chlorosis, respiratory disorders and *chronic* skin diseases, as psoriasis and eczema, often receive benefit at Bath. I have, however, seen much irritation in several cases of subacute eczema sent to these baths, and there seem to be many nervous irritable subjects with whom they do not agree: contra-indications are much as mentioned under Buxton. It has been called the English Teplitz, but differs in being only 100 feet above the sea and by no means a “Wildbad”.

Teplitz, now known as Teplitz-Schönau, in Bohemia, is one of the oldest (pre-historic) and most frequented spas and is pleasantly situated in an open valley sheltered by mountains about 700 feet above sea-level, having a moderately good but changeable climate. The waters are weakly charged with alkalies and alkaline earths. In a recent analysis by Professor Oscar Liebreich it is pointed out that the total solids in ten litres of this water amount to 7.2694 (0.73) per litre, whilst the accepted maximum for “indifferent waters” is 0.68. Sodium carbonate forms more than half the amount (which is also unusual), and sodium sulphate and chloride and calcium carbonate $\frac{1}{10}$. Carbonates of lithium, strontium and iron are also present; thus it leans to the class of alkaline saline spas—or rather has a position of its own. He notes how readily the water wets, *i.e.*, adheres to the skin; the small proportion of calcium sulphate is enough to prevent chill after a prolonged stay

in the bath, whilst it is not enough to cause irritation (bath-rash). It is strongly recommended in gouty cases. In neuralgias, facial, brachial and intercostal, it is more often used tepid. There are eight large establishments. The baths are generally given very warm (105° to 109° F.) and followed by one or two hours of gentle perspiration in bed. Rooms are to be had in most of the bath houses. If mineral waters are drunk, they are generally the more active ones obtained from Carlsbad, Bilin or Püllna.

The moor baths at Teplitz are also given hotter (99° to 100° F.) than elsewhere and are said to be more soothing, and less stimulating than at Franzensbad. These and the waters are often extremely useful in chronic gout and rheumatism, sciatica and other neuralgias; they are used in some forms of chronic skin and bone disease, wounds and ulcers, many cases of which are sent to the local military hospitals,—Saxon, Prussian and Austrian.

Plombières—"the French Teplitz"—on the sides of a river valley, 1,300 feet up in the Vosges Mountains, has similar, rather weaker, but hotter springs (77° to 155° F.) with a trace of arsenic; some of them are specially "soft waters" containing silicate of aluminium; there is also a chalybeate spring, but the treatment is more by prolonged bathing and douche than by drinking. The "douche horizontale," which is an enema or washing out of the bowel, continued with intervals for perhaps an hour at a time, is a speciality of the treatment. The season begins late—towards the end of May—and lasts till mid October, and the cases benefited are mostly nervous and gouty forms of dyspepsia, chronic gastralgia and mucous and membranous catarrh of the stomach or intestines.

Luxeuil is about the same altitude in the western part of the same mountains; the waters are similar (108° to 125° F.) and are used for the same class of cases, as well as for rheumatism, etc. The season begins earlier. Both baths were in use in Roman times.

Bains-les-Bains near Plombières is a quieter spa with "indifferent" waters— 84° to 122° F.—which have special repute in hysterical cases.

Neuhaus in Styria (not in Bavaria, which is a soot-bad), called Töplitz bei Neuhaus, at a height of about 1,000 feet, has "indifferent" waters at 98° F., also a chalybeate.

Dax (De Aquis), about thirty miles from Bayonne, is an old Roman bath on the banks of the Adour with springs from 88° to 140° F., but has a special reputation for baths of the mud left after inundations of the river, and these are used quite hot, up to 120°, for chronic rheumatism, arthritis, sciatica, uterine and nervous disorders. The climate is mild and the spa is open in winter.

Chaudes Aigues is another thermal French resort, but higher (2,000 feet) and with more alkaline iodised waters up to 180° F.

Vöslau, an hour's journey south from Vienna, is much esteemed in Austria for its pure air and charming position at 700 feet altitude, on vine-clad slopes, and its thermal waters (75° F.). These are used for bathing, chiefly by ladies for hysteria, nervous and pelvic disorders, anæmia and convalescence after illness. Whey and grape-cures are available.

Wildbad.—*The* Wildbad of the Würtemberg Black Forest, half an hour from Pforzheim, is more than 1,300 feet up in the mountain valley of the Enz, with pine-clad slopes; it runs from north to south and has a variable but cool and bracing climate. There are fine bath-houses with luxurious single, or plainer "company" baths for four or six persons (Gesellschaft-bäder). The arrangements are good, the surroundings beautiful, and the life simple, though now large numbers congregate there. In the special "Wildbad," the water which rises from a sandy floor to run off by an overflow pipe, so as to imitate bathing in a fountain, is neutral with much nitrogen; temperature 91° to 104° F.; cold baths (of this, cooled), hot air and vapour and electric and gymnastic appliances are employed. I have received excellent accounts of tonic bracing effects here in nervous debility and convalescence, but it is also resorted to for all the disorders already enumerated, chronic rheumatism and gouty troubles, sequelæ of wounds and injuries, nervous disorders functional and even organic such as paralyses, dyspepsias, women's diseases, and skin eruptions.

Liebenzell is beautifully placed in another valley about eight miles from Wildbad and has similar waters but cooler (72° to F.), and is much used for female diseases.

Freudenstadt is also well spoken of and has pine baths.

Badenweiler is beautifully situated, with a fine Kurhaus and hotels and a splendid park, at an altitude of 1,400 feet; it is within easy reach of Freiburg. Still higher (1,750 feet) and a quarter of a mile away in the woods is **Haus Baden**; the air is mild, as it is sheltered from all winds but the west, and is therefore recommended for delicate chests: graduated walks are arranged. There are many "indifferent" springs, with a temperature of 79° F., and the noted "marble" and other baths which are soothing for irritable nervous cases and are also used as above: sometimes pine or "sool" is added. The place, however, is more frequently prescribed as an air and rest cure. One of the best preserved of Roman baths in Europe is here.

St. Blasien, also in the Badish Black Forest, higher (2,300 feet), in an open well-watered valley, has a fine Kurhaus with excellent installation of baths, and deserved repute, especially for nervous disorders, dyspepsias, and some diseases of women (only open in the summer). There is a well-known open-air sanatorium here, and another more modern and very fine at Todtmoos; also the Louisenheim for chronic illness.

Néris (Allier, France), in a river valley about 1,200 feet above the sea, has feebly alkaline waters (sulphate and bicarbonate of sodium) at 102° to 127° F.; employed chiefly as baths (rather prolonged) and douche with massage, etc., for which there is a good installation. It is largely frequented by French women for uterine, ovarian and nerve disorders.

Schlangenbad has a special repute for neurasthenia and irritable nervous conditions, insomnia, etc., due to overwork, or illness, as well as for pelvic and spinal congestions, dysmenorrhœa and climacteric disorders. I have found it useful for alcoholic cases—women especially—with gastric catarrh, and for erythematous and acneform dry scaly conditions of the skin. There are ten thermal springs (81° to 89° F.), of which the Marienquelle is for drinking only, the others for baths and douches. They contain but small quantities of the usual alkaline and earthy salts with nitrogen, oxygen and free carbonic acid, and are remarkably clear, transparent and soft to the taste as well as to the touch, "like satin," so that they are valued as "complexion-waters" and largely exported as such, whilst locally the place is known as a "beauty bath". It lies in a beautiful wooded valley of the Taunus

range, open to the south-west towards the Rhine, about 900 feet above the sea-level, so that it has a modified mountain climate and is the mildest of the Wildbäder. Doubtless much of its good effect as a nerve sedative is due to its surroundings, almost all the houses being detached and opening on the extensive forests, but these have the drawback of dampness in spring and closeness in the heats of summer.

Others in this class that deserve mention are **Mallow** (the only one of the kind in Ireland), **Chaudfontaine** (Belgium), **Aix** in Provence, and **Römerbad** in Styria, which has a similar reputation to Schlangenbad and lies at about the same altitude with somewhat warmer waters (95° to 102° F.). **Tüffer** is near, and on the same line of rail to Trieste. Important higher resorts are the following:—

Johannisbad near the Riesengebirge is at a height of more than 2,000 feet, and has neutral waters of moderate warmth (84° F.), also a chalybeate. It is used as an after-cure in conditions of general debility and functional nervous disorders.

Ragatz-Pfäfers.—The springs of “indifferent” thermal water (98° F.) are at the latter place, which is in a narrow ravine at upwards of 2,000 feet altitude, and are conducted in wooden pipes thence to Ragatz, about 400 feet lower (the distance between being three miles), through the Tamina Gorge to where the river opens out in a beautiful and more sunny valley. Here there are modern bathing arrangements for swimming, douches and electric baths and hydrotherapy (cold) as well as for massage and gymnastics. Much larger amounts of water to be drunk, and much longer hours to be spent in the baths (as at Leukerbad) were formerly prescribed than is now the custom. The season is naturally earlier at Pfäfers and later at the lower spa, but the cases sent to both are similar, *viz.*, chronic rheumatism, gout and joint troubles, early stages of some cerebral or spinal disorders, neuralgia, sciatica, chronic female diseases, and cutaneous eruptions. The altitude and the picturesque surroundings make the spa a good one for convalescence and after cure. It is in the Canton St. Gall, on the rail to Chur.

Gastein (Wildbad-Gastein), a few hours’ drive from Salzburg, in a beautiful part of the Tyrol, is one of the highest baths, being 3,300 feet above the sea-level. “The houses are grouped round

the edge of a mountain torrent, which forms a splendid waterfall," and are surrounded by grand and mountainous scenery. The climate is bracing, and rather rough and rainy, but not so variable as at other mountain resorts. The social tone is monotonous and quieting for excitable subjects except, perhaps, in the height of the season (July to end of August) when the accommodation is apt to be overtaxed; the noise of falling waters is also trying to some. The waters are clear and soft, temperature 78° to 121° F., and slightly mineralised—1 lb. contains only $2\frac{1}{2}$ gr., and more than half of this is sulphate of sodium; they are used in warm baths for from ten minutes to an hour. The methods in use at Gastein are milder than at Teplitz, though there are some similar very hot baths for rheumatic exudations, neuralgia and atonic paralyses; the place has a high reputation in such cases, also in chronic metritis, nervous dyspepsia, hysteria, hypochondriasis, and impotence. If the last-named condition be due to overexcitability of the lumbar cord from sexual excess, it may be relieved by sedative baths; but if from spinal paralysis, it is not likely to be so, and hence very contradictory results have been recorded by different physicians (Braun). Sometimes the cold-water system, or Rehme or Schlangenbad, will succeed better. It is especially suited for slight cases, *i.e.*, functional nerve disorder. Cases of early locomotor ataxy are also sent here, and it is said with benefit. As a mountain air cure it is useful after illness and after the more exhausting cures of Kissingen, Carlsbad, etc.

CLASS 3 (A).—ALKALINE WATERS.

Vichy, in the Auvergne district of Central France, about 750 feet above sea-level, on the right bank of the shallow sandy Allier, lies in a flat but cultivated country circled by low hills, beyond which lies finer scenery. It has, however, thanks mainly to the third Napoleon, all the attractions of fine buildings, the Parc Anglais, a splendid "establishment" with all modern baths, etc., and a luxurious Casino, and has long been the most fashionable and frequented spa in France. It is open all the year, with a "season" from May to October. The climate is mild and said to resemble that of Paris, but in midsummer is apt to be very

hot and thundery, in autumn foggy. There are many springs, in fact wherever the ground is bored they are found; such are the Source Lardy (carbonated iron) and Larband (alkaline), named after the proprietors, and used more for export, but the best known are (1) Grande Grille (named from the iron railing formerly round it), which is hot, $108\cdot5^{\circ}$ F., and contains about 70 gr. of sodium bicarbonate in the bottle (one quart) with about 8 of chloride and small quantities of sulphate, phosphate, arseniate and borate, as well as bicarbonate of potassium, alkaline earths, and free carbonic acid. It is active and stimulating at the time of taking and is ordered for hepatic disease, gall stones, etc., even in weakly persons and especially those affected by tropical climates. (2) The Hôpital is not so hot (89° F.), but contains some grains more of alkali and much more carbonic acid, also some organic matter which renders it "softer"; it is less exciting and is given for gastro-intestinal catarrh, and other forms of indigestion. (3) Puits Chomel, also strong in soda but with less gas, is used for throat affections and pharyngitis. To the discovery of (4) the Célestins (three sources), which are of equal strength but all cold, much importance was attached; the waters are sparkling and more agreeable, and are taken as diuretic in gouty renal disorders, calculus and vesical catarrh. Two of the three springs contain more iron, but this is sought rather in stronger chalybeates. (5) Mesdames and S. Marie, at Cusset, a more picturesque town two miles away, are given for anæmia, especially when secondary to dyspepsia, etc. (6) Haute Rive, a strong alkaline cold chalybeate, richer in carbonic acid, and (7) Saint-Yorre, a strong cold alkaline water, some miles from Vichy, are largely bottled for exportation, as indeed are most of these waters. They are also evaporated for extraction of salts for baths, pastilles, etc. Although not as a rule laxative, they are used a good deal in the treatment of obesity; also in glycosuria, utero-vaginal complaints, rheumatism and gout, and there is no rigid adherence to the use of one spring in the different maladies mentioned above.

Whether soda waters like these are the best remedies available for gout is now more commonly disputed than formerly (*v. Soda*). Clinical experience at Vichy must be reckoned conclusive on this point, and the practical result of such explanation as contrasted with the old theory of *antidotal* action is that smaller doses are

now given, sometimes half a glass twice a day to begin with, gradually increased to four or five. The chalybeates may be taken with meals. Barudel maintained that Vichy waters so useful in articular gout were hurtful in the irregular or visceral form, which required more cautious treatment and generally less active waters.

The thermal waters at 85° to 95° F. and more or less diluted (in order to avoid headache) are largely used in *baths*—generally continued for about an hour—and in all forms of *douche*, gastric (by lavage), rectal, perineal and vaginal, as well as over the liver and spleen; also in vapour and inhalation and by all the methods of hydropathy; carbonic acid is also utilised.

Similar, but more alkaline and quite cold (54° to 64° F.), waters are at **Vals** (Ardèche), an important spa between Valence and Avignon, known as the “cold” or the “Southern” Vichy, situated in wilder and more interesting country on the rapid Volane, in the heart of a group of volcanic mountains picturesque and well wooded, at an altitude of 790 feet. Life there is quieter, but not without distractions.

It has the further advantage of a remarkable gradation of mineral strength in its numerous springs, which may be grouped into (1) strong, containing from 100 to 130 gr. in the quart of sodium bicarbonate, with some sulphate, chloride, bicarbonate of potassium, and alkaline earths, and more or less ferric oxide and carbonic acid; (2) medium, with about half the quantity of alkali and rather more chloride; (3) weak, with from only 10 to 12 gr.; (4) and arsenico-ferruginous, weakly alkaline, but containing what is considered an effective dose, about $\frac{1}{20}$ gr. of arsenate of sodium, and $1\frac{1}{2}$ to 2 gr. sulphate of iron.

The best known are in group 1, such as Magdeleine—the strongest of soda waters—given for excessive acidity, gastralgia and dilatation of the stomach, gout, rheumatism, obesity, albuminuria, glycosuria, and dependent nerve disorders. The Constantine is also very strong. The Souveraine contains nearly $\frac{1}{2}$ gr. of lithia per litre. Précieuse is very gaseous and recommended for obstructions—congestive, hepatic or intestinal, alcoholism, etc. Désirée, with much chloride, for renal and vesical disorders. Rigolette, with more chloride and some iron, for anæmia, debility, neurasthenia, and in group 4, Dominique and St. Louis for the

same, and for chlorosis, pulmonary disorder, skin diseases and malaria. The Pauline, the Chloe, and the Vivaraise springs are included in groups 2 and 3 which are utilised for different degrees of dyspepsia and gastric catarrh; the St. Jean, with less than 30 gr. of bicarbonate and 1 or 2 of sulphates and chlorides, is used as a table water.

There is a fine establishment for baths of all kinds and a specialty for inhalations and local injections of carbonic acid gas for laryngo-pharyngitis, emphysema, blepharitis, vaginitis, etc. The mud of the arsenico-sulphurous springs is also applied locally.

Neuenahr has recently come into vogue as a spa of the same character as Vichy, but milder and suited, *e.g.*, for liver and kidney cases and atonic gout and rheumatism in persons with weak circulation, not able to stand the stronger waters of Carlsbad or Marienbad, Tarasp or even Homburg. It is reached easily from the Rhine station of Remagen, and lies in the valley of the Ahr about 700 feet above the sea, but at the foot of a high, wooded hill and closed in on three sides so that it is liable to be very hot in summer; at other times it is mild, and sometimes foggy. The valley up to Ahrweiler the mediæval town, and Altenahr with its ancient castle, the river winding amongst steep rock and vineclad hills, are "picturesque in the extreme" (Yeo). The Grosser Sprudel (104° F.) bubbles and foams into a basin, being highly charged with carbonic acid, but not strongly mineralised; it contains about 15 gr. of sodium bicarbonate in the quart, a trace of chlorides, 4 to 5 gr. of bicarbonates of magnesium and calcium, .04 bicarbonate of iron, and is only a quarter the strength of the Vichy springs. The Victoria and other springs are not so hot.

Besides the disorders mentioned, chronic arthritis is said to improve and also glycosuria, specially that of later life connected with gouty conditions, chronic nephritis, acid dyspepsia, with obesity and hepatic disorder; functional nerve troubles, and also chronic bronchial catarrh, emphysema, and even chronic phthisis are sent here with more or less advantage. There are spray rooms for inhalation as at Ems and Aix. *En route* from Remagen, near the Landskron rock, one passes the Apollinaris Brunnen, so much used as a table water and containing about half the amount of bicarbonate with a little more chloride and sulphate. It is useful

in irritable conditions of the stomach, and as a medicinal water in the lithic acid diathesis and gout; also in bronchial catarrh and tendency to gall-stones.

The water of **Gieshübel**, near Carlsbad, contains a small proportion (20 gr. to the quart) of bicarbonate of sodium, with a large amount (55 cub. in.) of carbonic acid. It is pleasant and refreshing and exerts a moderate antacid effect.

Bilin, in Bohemia near Teplitz, and **Fachingen**, in the valley of the Lahn, contain strong soda springs, which, however, are but little used on the spot, though they are exported in large quantities. The water of Bilin contains 33 gr. of bicarbonate in the 16 oz., with chloride 2 gr., and sulphate 6 gr., lime 4 gr., a trace of iron, and much carbonic acid, at a temperature of 53° F., and generally requires to be heated. That of Fachingen is very similar, some analyses give a few grains more, others less, the amount of carbonic acid is nearly double. Both are used for severe cases of gravel, gout, and gastric, bronchial and vesical catarrh.

Bilin has a bath establishment and a whey cure; its water is somewhat laxative owing to sulphate; the course is often commenced or ended at Teplitz.

Birresborn, on the line to Treves, has a similar spring, rather weaker in soda but with sufficient sulphate and magnesium bicarbonate to be slightly laxative. It contains also traces of chloride, iodide and bromide of sodium, iron, and manganese, and is much used as a table water and for acid dyspepsia with constipation.

At **Château-neuf** in the mountains of Auvergne, and **Le Boulou** in Southern France near the Spanish frontier, there are alkaline waters of similar type, and of local repute for anæmia, dyspepsia and rheumatism.

Bad Salzbrunn or Obersalzbrunn is a more frequented spa in Silesia, two hours from Breslau, situated in a wide valley protected by wooded mountains, 1,320 feet above the sea-level, with a sub-Alpine climate and cold soda waters. It has been called the cold Ems, and is recommended in bronchial catarrh and early phthisis. The Oberbrunn contains over 30 gr. of sodium bicarbonate to the quart with a few grains of sulphate and chloride, traces of phosphate, iodide and bromide, bicarbonates

of other alkalies and alkaline earths, notably lithium, with much carbonic acid, and is given in cases of uric acid diathesis as well as in all forms of catarrh, biliary colic, emphysema and pleuritic exudations, obesity and diabetes. The Mühlbrunn is milder, and the Kronen and Wilhelmsquelle which rise near have only about $\frac{1}{3}$ as much alkali. These are some of the most largely exported waters and have the advantage of keeping well.

Moor and other baths of all kinds, pneumatic and other inhalations are available; also sterilised milk from cows, goats, sheep and donkeys, and wheys of all kinds.

CLASS 3 (B).—MURIATED ALKALINE WATERS.

Muriated alkaline waters have a larger proportion of sodium chloride and this is considered to lessen their lowering and thinning properties; as a rule, when tissue-change is to be increased, and at the same time tissue growth promoted and gastro-intestinal secretions stimulated, soda waters containing common salt are to be preferred.

Ems, near Coblenz, amidst wooded hills in the beautiful but narrow valley of the Lahn, is the type of this class, and one of the oldest and most famous. Braun called it "the pearl of Germany," and it has been much improved of late years. Besides the splendid Kursaal and covered promenades in gardens along the river, and the Kurhaus with baths and douches, sprays, gargles and pneumatic inhalations, there are now more complete mechanical and medical arrangements for the treatment of chronic bronchitis, asthma, emphysema, etc., than perhaps anywhere else.

The climate is mild—in July and August often too hot and relaxing—though fresh in the morning and evening: in autumn perhaps misty, but this has been met by the extensive use of the "funiculaire" to the top of the Malberg (1,000 feet), where chest cases recline all day under shady trees.

The waters are, with the exception of one chalybeate, all of the same character, *viz.*, hot, of medium alkalinity—20 to 30 gr. of sodic bicarbonate in the quart, with about half the amount of chloride, small amounts of calcium and magnesium and traces of other alkalies and alkaline earths, and a good

proportion of carbonic acid. Of the six springs used for drinking, choice is made according to temperature for different cases—the Kesselbrunnen is at 120° F. ; Fürstenbrunnen, 102° F. ; Kränchen, 90° F. ; Victoria, 80° F.—they are often given with goats' or asses' milk.

Cases that require soothing rather than bracing are suitable for Ems—such as, besides those already mentioned, nasal catarrh, laryngitis, irritable cough with little secretion, sequelæ of pneumonia and pleurisy. Phthisical patients require much consideration before sending them there, as the warm air and waters have induced hæmoptysis ; but the early dyspepsia of such cases is benefited. Gastralgia, hepatic congestion and gall stones, glycosuria and albuminuria, gout, eczema, urticaria, prurigo and disorders of women such as dysmenorrhœa, leucorrhœa, uterine catarrh and metritis are all sent there.

A large part of the practice of Ems is in these latter cases and the warm ascending vaginal douche—Bubenquelle—has earned special repute.

Royat is a modern, but now almost an equally important spa of this class, and has been called the French Ems. In the heats of summer it has the advantage of climate and position, for it is 1,400 feet above the sea on the slopes of the Puy-de-Dôme (Auvergne) at the entrance to a ravine and circled by mountains, except towards the east, where it looks down on Clermont-Ferrand (a mile away) and extensive plains. The volcanic neighbourhood makes it liable to sudden storms and to dust, but the climate as a whole is specially dry and sunny, with cool mornings and evenings. Of the four springs, the Eugénie (95° F.) contains about 20 gr. of bicarbonate of sodium in the quart, with nearly 16 of chloride, rather less bicarbonate of calcium, traces of iron and still smaller ones of lithium and arsenic. The Saint-Victor (68° F.) has rather more iron, the Saint-Mart (88° F.) slightly more lithium, whilst the César (84° F.) is but feebly mineralised and is used as a table water. There is now also a Source des Médecins or Goudronneuse which contains some dissolved mineral tar, and a Source Fonteix with excess of carbonic acid which is bottled as a lithia water. All are rich in carbonic acid (there are also baths of this gas) and, though limpid at first, become turbid or greenish on exposure. They are used in all forms of bath, douche, inhalation and for

swimming. For drinking it has become the mode to order only small doses, half tumblers twice a day. Professor Gubler called these waters "mineral lymph," thus indicating their chemical resemblance to blood serum.

They are used in chronic gout and rheumatism, especially in anæmic and weakly persons who cannot stand Carlsbad treatment, and in associated forms of atonic dyspepsia, in chronic bronchial catarrh and asthma, laryngitis, pharyngitis and early phthisis; in cutaneous disorders, acne—simple and rosaceous—and limited eczema: diabetes and chronic albuminuria, anæmia and chlorosis and the special disorders of women; in fact the list of suitable maladies for Royat is almost the same as for Ems (*Lancet*, ii., 1887).

Saint-Nectaire, in the same neighbourhood, has been specially advised for "gouty and phosphatic albuminuria" (*Ducrohet*).

Tönnistein, Assmannshausen, and Weilbach (in Rhenish Prussia and Nassau) are more or less strong, but less known waters of the same class.

Gleichenberg in Styria, three hours from Graz (on the line to Trieste), is much better known abroad, and frequented for its mild climate (in well wooded country 1,000 feet above the sea-level), and its cold gaseous alkaline muriated waters for chronic (including tuberculous) affections of respiratory organs and dyspeptic conditions. There is also an alkaline and gaseous chalybeate.

Luhatschowitz (in Moravia, two hours from Vienna) is situated in a pleasant valley of the Carpathian Mountains, 1,600 feet above the sea, and has a large well-fitted establishment, parks, gardens and extensive covered walks. The springs, four in number, are cold, and contain in each pint from 30 to 60 gr. of bicarbonate of sodium, 20 to 30 gr. of chloride, with traces of iodide, bromide, and borate of sodium, 4 to 5 of carbonate of lime, and a large amount of carbonic acid.

"They are the ideal of strong carbonated muriatic soda waters," and are valuable in severe catarrhal conditions, especially in chronic gastric catarrh, and in abdominal congestions, gouty exudations, uric acid, gravel and respiratory disorders. In cases of hyperæmic enlargement of the liver they even come into competition with Carlsbad water, and where the strong soda waters of Vichy, Bilin, etc., have failed in their effect, it is well worth

while to try a water containing more chloride, which salt increases the effect of the carbonate.

Roisdorf near Bonn, Rosbach near Homburg, Kronthal and Taunus near Frankfort, Geilnau and Selters in Nassau have similar but weaker springs, particularly used as antacid table waters. Of the Kronthalbrunnen three kinds are exported, an "indifferent" (blue label), an alkaline muriated (red), and a chalybeate (green).

Of Selters, Ober and Niederselters are similar and remain the popular best type of this class; as table water the former is preferred, containing in 16 oz., according to Kushner, nearly 10 gr. of sodium bicarbonate, 15 of chloride, 2 of calcium and magnesium bicarbonates, a trace of iron and manganese, and of various phosphates as well as of fluoride and bromide. Mohr adds traces of ammonia, baryta, strontia and various acids besides carbonic.

The natural temperature is 53° F., the flavour fresh, agreeable and thirst quenching; it is colourless when fresh, but opal-tinted after exposure, from precipitation of the small quantity of iron.

*CLASS 3 (C).—SULPHATED ALKALINE (COMPOUND SODA)
WATERS.*

These waters contain sufficient sulphate to render them aperient.

Carlsbad, in the north-west corner of Bohemia near Eger on the small rapid Tepl, in a wooded valley 1,200 feet above the sea-level, is one of the chief, as it is the oldest of German (Austrian) spas. The lower parts of the town are close, but it rises in terraces on the granite hills and now many villas and hotels are to be found high up where the air is fresher; a local boast is that "from time immemorial" it has been free from epidemic disease. There are fine forest walks and drives, covered promenades, splendid bath houses, Kurhaus and music, etc., of the best. The season opens by mid April and lasts until November; earlier and later the climate is apt to be "rough" and damp, but that does not prevent the coming of patients all through the year.

The valley is rich in hot springs (nineteen), of which the principal ones differ little in their fixed constituents, though much in their temperature and gaseous contents. The Sprudel, which bursts

up in fountain-form of varying height with clouds of steam, has a temperature of $162\cdot5^{\circ}$ F., about 30 gr. of sodium sulphate in the quart, chloride 16, carbonate 20, with a little lime, magnesia, iron, etc. The Felsenquelle is at 138° F. The Schlossbrunnen, at 111° F. (or 124° F.), has more carbonic acid. The Marktbrunnen, at 104° F. (or 130° F.), has some iodide and bromide, etc., but all come probably from the same reservoir of waters under the soil, which itself gives off steam, especially along the river.

Carlsbad water is clear, odourless and colourless, rather unpalatable, of faint saline taste, not nauseating. The hotter springs are as a rule less laxative than the cooler; most of them are besieged by large numbers of patients between six and eight A.M., when from half a glass to two or more (of 6 oz. each) are sipped slowly with intervals. Much larger doses were formerly taken, especially when bathing was unpopular, but now even those mentioned are often divided between early morning, fore- and after-noon; sometimes the waters are cooled at home and taken at bedtime and on rising.

They are efficacious in several forms of dyspepsia, *e.g.*, when gastralgia and flatulence occur principally after meals, and when catarrhal conditions of the stomach or intestine are present, and morning vomiting, or diarrhoea alternating with constipation. Periodic headache connected with such conditions is relieved at the same time. Ulcer of the stomach and duodenum, and dilatation are included by some (Ewald, Leube, etc.). For corpulence with its various troubles they are, in conjunction with diet, a tolerably sure and gentle remedy, independently of violent evacuations. In curable forms of jaundice, early stages of alcoholic cirrhosis and biliary colic, and a tendency to gall-stones and allied conditions, the waters diminish the inflammation and tumefaction in the gall-ducts, and thus enable calculi to pass more easily. In hepatic and splenic enlargement following malarial fevers, especially if constipation be marked, and in passive hyperæmia of the portal system and abdominal viscera occurring in stout florid persons with a tendency to hæmorrhoids, and generally sluggish venous circulation, Carlsbad waters are very effective. Old Indians with enlarged livers often derive remarkable benefit. The hypochondriasis dependent more or less on the above-named conditions is also relieved. In gout and gouty

conditions without much affection of the joints, especially in patients with abdominal plethora and commencing atheromatous change in the vessels, in rheumatoid arthritis, sciatica, and in the tendency to uric acid concretions and consequent catarrhal affections of the urinary organs after operations for stone, in some forms of albuminuria and prostatic hyperæmia Carlsbad waters are often quite as useful as the stronger alkaline waters. In cases of the *slower* and *milder* form of diabetes, the use of Carlsbad waters has rapidly and considerably diminished the excretion of sugar, and after some months has effected great improvement in the general condition in many instances. Even in serious cases, provided that they are not very acute and rapid in their onset, and not accompanied by phthisis, the same waters have often effected an improvement, and checked the progress of the disease.

In these observations I find myself in agreement with Seegen, Kraus and Braun, and have only to add that the course at Carlsbad need not, and should not, be so conducted as to "purge, lower, and starve" the patient. We sometimes hear complaints of the depression and debility induced, and certainly an excessive use of the waters is very lowering, but effective therapeutical results may be obtained without this. The diet, though restricted, should be nourishing, butter and fats are no longer wholly prohibited and a more substantial evening meal is allowed; exercise is to be kept within moderate limits and sufficient rest—mental and bodily—secured during and especially after the treatment (B. M. J., ii., 1887-88). Baths are not an invariable part of the Carlsbad programme, but may be had in any form, cooled mineral water, vapour douche, mud or iron.

The bottled waters are largely exported and, though generally warmed for use, are often found more purgative if taken cold. It is not generally known that the crystallised natural Sprudel salt does not profess to represent all the constituents of the water, but only sulphate 37 per cent., carbonate 6 per cent. with 3 of chloride: one to two teaspoonfuls of this dissolved in water, preferably hot, is antacid, laxative and diuretic. The powder form of the salt is an improvement, it represents more of the constituents, excluding only the earthy carbonates, and it is more palatable and does not deliquesce in hot weather. One teaspoonful (75 gr.) contains

about 30 gr. of sulphate, 16 of bicarbonate, 14 of chloride, with traces of borate and fluoride of potash, lithia, iron, lime and magnesia. Tablets of similar composition are prepared, and small doses may be taken for acidity, etc.

Marienbad, a few hours' drive to the south of Carlsbad, lies in a broad beautiful valley open to the south (and so fully exposed to the sun), but sheltered on three sides by gently rising pine and fir-wooded hills which are intersected by paths and roads. Situated nearly 2,000 feet above the sea, the climate is not mild, but it is dry and pure, and it is said that cold is taken less often here than at Carlsbad; also it may still be called quieter and less crowded and more sought after by ladies, but recent years have witnessed a very large accession to its *clientèle*. The waters are of the same type but stronger in sulphate, and cold—the place has indeed been called the “Cold Carlsbad”—but it is more than that, possessing good chalybeates, and also an alkaline earthy spring; it is available for so many forms of illness as to be called a “family spa.”

Of the sulphated sodium (Glauber's salts) springs, the Ferdinandsbrunnen contains double the amount of sulphate and also of chloride than the Sprudel of Carlsbad contains, and slightly more carbonate, also very much more carbonic acid. The Kreuzbrunnen also exceeds, though not so largely; the other two are weaker. They are used for similar cases, disorders of the stomach and bowels, biliary and renal calculi and diabetes, with perhaps special repute for obesity, fatty heart and abdominal plethora, and much stress is laid on the fact that the relief given is not due simply to purgation, but to increased tissue change and oxidation. The waters sometimes agree better when warmed.

The weaker springs (Waldquelle) are used more in respiratory catarrh and emphysema. Of the chalybeates, the Ambrosiusbrunn contains rather more iron than Schwalbach or Pyrmont, and is ordered in chlorosis and anæmia, especially with obesity, and at the climacteric period, perhaps mostly in the form of baths. The alkaline earthy Rudolfsquelle contains more bicarbonate of lime and magnesia than Wildungen, and is used in like cases of chronic vesical catarrh, urethritis and pyelitis, which require a more prolonged course.

Baths are given with the Marienquelle, which contains an

unusual amount of carbonic acid, also with the gas itself, and with the local peat, which has a large amount of iron oxide. These are for chronic rheumatism and gout, sciatica, metritis and exudations generally; the gas baths are said to soothe the general nervous system whilst relieving local pain; they cause a subjective sensation of warmth.

Franzensbad, not quite so high or so picturesque, is about three miles from Eger, on and surrounded by moorland and peaty bogs, and though founded by an emperor (Francis II.—from whom it is named) is still more a ladies' bath than the last. Of the many sources, the Salzquelle and several others much resemble those of Carlsbad, but are cold, rather stronger of sulphate (18 to 27 gr.) and of carbonic acid. Others such as the Neuquelle have more iron, while the Stahlquelle is a strong chalybeate (bicarbonate) with a small amount of sodium sulphate.

The treatment at this spa has always been milder—with smaller doses—and more stimulating and tonic than at Carlsbad, and better adapted for dyspeptic, weak, thin, hypochondriacal and hysterical subjects. In such cases, and especially in anæmic women with neuralgic pains and uterine disorder, and perhaps with hæmorrhoids, benefit is obtained here when stronger and more astringent chalybeates would not agree. Digestion is promoted, the nervous system strengthened, and the circulation stimulated. Bathing forms an important part of the treatment. There are Stahlbäder, where the mineral water is warmed in such a manner as to retain most of the carbonic acid; Luisenbäder, in which most of the gas is driven off by steam, so that they are less stimulating; and special Moorbäder; these are made from the local peat, sifted and long soaked with mineral water, in which most of the constituents—including much iron sulphate—are soluble, forming a dark semi-fluid mass which is heated by steam from 89° to 95° F., and then applied to special parts or in bath (not generally above the cardiac region), in rheumatic and gouty cases, generally in the delicate, in hyperæsthesia, hysterical spine, some chronic skin diseases and ulcerations. They are contra-indicated in hæmorrhagic and cardiac cases. The mineral water baths are much used for leucorrhœa, vaginal catarrh, etc. Carbonic acid gas baths, local and general, are also in frequent use at Franzensbad and prove of great benefit to some cases.

Tarasp-Schuls-Vulpera are associated in an important mountain spa, with magnificent surroundings about 4,000 feet up in the Lower Engadine, six hours south-east of Davos by diligence through the Fluela Pass. The Tarasp Kurhaus, a fine building with gardens, etc., is in a gorge through which flows the river Inn, and the baths and principal waters are within the building and grounds. Schuls is a populous village extending from the riverside up the mountain slope about a mile away, and has hotels and a bath-house where the chalybeate (Wyquelle) is used. Vulpera is higher still on an open sunny plateau amidst wooded hills on the opposite bank. The climate whilst truly Alpine and invigorating is not so rigorous or changeable as in the Upper Engadine (St. Moritz), and though this is one of the least rainy districts, it is not so dry, rarefied and exciting to irritable nerves (Yeo). The valley is sheltered from north and north-east, still the winter snow does not melt before May, and the bath season, which is now crowded and fashionable, is more simple than at Carlsbad. It does not begin before 1st June, and the weather remains as a rule temperate and pleasant till mid September.

The cold sulphated waters (locally "Salzwasser") St. Lucius and Emerita are remarkable in combining the qualities and ingredients of several noted springs; thus the amount of sodium carbonate in the quart is much the same (68 gr.) as in the Grande Grille at Vichy; of sulphates (31 gr.) as in the Sprudel of Carlsbad; of chlorides (50 to 70 gr.) more than half as much as in the Rakoczy of Kissingen, whilst the volume of carbonic acid is greater than in any, making it more pleasant to take and more readily absorbed. Lime 35 gr., magnesia 12, and iron a trace, are also contained in it. The waters are used in much the same cases as the others named, especially in chronic constipation, bronchial, vesical and gastro-intestinal catarrh, prostatic enlargement, hæmorrhoids, glycosuria and chronic albuminuria of stout persons; of these, digestive disorders are the most frequently treated at Tarasp. The other two springs, Bade and Ursus are used for gaseous saline baths.

Chalybeate baths are also given (Caroldquelle). Of the iron springs near, the Bonifacius which resembles the Rudolfsquelle at Marienbad contains more than $\frac{1}{10}$ gr., the Wyquelle more than $\frac{1}{5}$ gr. per 16 oz. with alkalies and alkaline earths in effervescence.

These are used in weak anæmic states, neurasthenia, early tuberculosis, etc. The arsenical chalybeate of Val Sinestra, three miles off, is brought to Schuls. The Suotsassequelle there has an "indifferent" carbonic acid water used for the table.

Elster, between Plauen and Franzensbad, has baths situated in a valley 1,550 feet above the sea with a fresh climate rendered milder by protection from the east winds. It has compound iron waters and mud baths like those of the last-named place, and also a sulphated alkaline water resembling the Kreuzbrunn of Marienbad and used in similar cases.

Bertrich near Cochem on the Moselle lies in a picturesque wooded valley 500 feet above the sea with a mild climate, simple and quiet but good and cheap arrangements, and medium sulphated alkaline waters, one-third the strength of Carlsbad. They are suitable therefore for sensitive delicate subjects of dyspepsia with liver and kidney complications, especially lithiasis and rheumatism. The tepid baths are soothing in irritable nerve disorders.

St. Gervais consists of a large establishment built in a ravine about 2,000 feet above the sea, on the diligence route between Belleville and Chamounix. It is now best placed amongst the alkaline sulphated waters, represented by two of its springs which formerly were classed as sulphur waters, but contain that element (calcium sulphide) no longer (Deligny, 1885),¹ though one other (Source du Torrent), a chlorated soda spring containing lithia, has also sulphuretted hydrogen. The hot springs Gontard and De Mey (102° to 108° F.) contain about 25 gr. each of chloride and sulphate of sodium in the quart with 10 of sulphate of lime, and though the amount of sulphate of lithium is small (1 $\frac{1}{3}$ gr.) it is double that of Royat. Together with some potash and magnesia there is enough carbonic acid to render absorption easier. The spa is much frequented by the French for some cutaneous maladies, eczema, especially of gouty type, acne and rosacea, urticaria, lichen, and furunculosis, also for gastralgia and atonic dyspepsia, constipation, hepatic congestion, hæmorrhoids, etc., and uterine engorgements, leucorrhœa, etc., for bronchial catarrh, uric acid, gravel and glandular enlargements.

¹ Similarly what was formerly the cold chalybeate no longer contains iron, according to recent analyses (Egasse, 1896). In 1893, the then establishment was suddenly overwhelmed by a torrent from the glacier of Mont Blanc.

CLASS 4.—SULPHATED AND SULPHATED-CHLORIDE (OR BITTER) WATERS.

These are still more active aperients, and many of them are principally used as such at home, rather than taken as a course at spas. They are as follows:—

The Friedrichshall water, which is largely imported from a spring in Saxe-Meiningen, contains in a pint: sulphate of sodium 46 gr., sulphate of magnesium 39 gr., chloride of sodium 61 gr., chloride of magnesium 30 gr., and sulphate of calcium and potassium, with a small amount of carbonic acid (Liebig; O. Liebreich gives rather higher quantities). This water is useful in small non-aperient doses for promoting tissue change, and in aperient doses is frequently prescribed for habitual constipation, hepatic congestion, abdominal plethora, etc.

The large amount of salt in this water is presumed to make it better borne by the stomach than some others.

The Hunyadi Janos waters, from near Buda, contain in sixteen ounces 138 gr. or more of sulphate of magnesium, 129 gr. of sulphate of sodium, with 11 gr. of chloride, and 13 gr. of carbonate of sodium. They are used in the same class of cases as those last mentioned, but are more active and are less unpleasant to the taste; the same observation applies to *Æsculap* and *Franz Josef*. The former indeed is advertised as “tasteless”; it contains about 120 gr. of magnesia and 90 of sodium sulphate in the pint, with chloride (about 20) and some carbonate of the same, sulphate of calcium, etc. The latter is somewhat stronger, with equal proportions of the sulphates and less common salt.

Royal Hungarian, Victoria Ofener, Ofen, Apenta and others of the group of “Hungarian bitter waters,” are in frequent use, but are not so active as the **Rubinat** and **Condal** from the Pyrenees; the former of which contains the large proportion of 675 gr. of sulphate of sodium in the pint with 23 of magnesia and 14 of chloride, so that half a wineglassful is quite sufficient; the latter has more than half the quantity of sodium sulphate with slightly more magnesia and chloride and also lime sulphate, and the dose is half a tumblerful. **Gran**, a water not generally known in this country, is still more active, containing over 300 gr. of magnesium sulphate in the pint ($4\frac{1}{2}$ per cent.);

Carabana is another Spanish water, strong (10 per cent. of sulphate) and theoretically excellent, but I have found the taste—sulphurous as well as salty—much objected to.

Püllna water (Bohemia) is preferred by some, being intermediate in strength, and containing 123 gr. of sulphate of sodium, and 93 gr. of sulphate of magnesium, some magnesium carbonate and chloride of sodium.

Seidlitz contains no sulphate of sodium, and 80 gr. of sulphate of magnesium, being practically about half as strong.

Birmensdorf (Canton Aargau) has a mild water with only 15 gr. of magnesium and $3\frac{1}{2}$ of sodium sulphate in the pint. The **Galthofer** (Moravian) are weaker still.

Of English sulphated waters, many formerly much in vogue are practically disused—such are those at Epsom, which contain 240 gr. of magnesium sulphate (Epsom salts) in the pint; at Beulah Spa (61 gr. with 9 of sodium sulphate and some chloride), at Streatham and Kilburn which resemble it, Sydenham Wells, Barnet, Cherry Rock (Gloucestershire), Victoria (Warwickshire), Melksham and Purton in Wilts. This latter spa, near Swindon, has 23 gr. of each sulphate, together with chloride, calcium sulphate, and some carbonic acid (which is deficient in most waters of this class); also traces of bromides, iodides and sulphuretted hydrogen. This water is used as an “alterative stimulant” in tuberculous sores and enlarged glands, threatened consumption, hepatic disorders, rheumatism, chronic skin disorders, and uterine derangements. Half a pint to a pint of the water is taken before breakfast and another half-pint in the evening. The air of the place is dry and bracing.

At **Scarborough** the south well contains 28 gr. of magnesium sulphate, but with rather a high proportion of calcium sulphate and carbonate.

Cheltenham, in the valley of the Severn, about 250 feet above the sea-level, sheltered from the north and east winds by the Cotswold Hills, is a pleasant and handsome town with well-planted streets and parks and fine public buildings. It has a nominal season from April to October, but is really more suited for residence in winter, when the climate is mild and dry, in summer it is hot and relaxing. The sulphated cold saline springs are of several qualities. That of the Royal Old Well, first noted

for the cure of George the Third, contains chiefly chlorides of calcium, sodium and magnesium, with sodium sulphate and a little carbonic acid. The Pittville Saline contains an unusual proportion of *silica*, but no sulphate of magnesia. Spring No. 4, Montpellier, contains a large amount of common salt (52 gr. in the pint), with 17 gr. sulphate of sodium, and 14 gr. of magnesium, but is deficient in carbonate of sodium and carbonic acid. This might be remedied, as Dr. Macpherson suggests, by adding a certain quantity of Bilin or of Vals water, and the temperature might be graduated. The Chadnor and Cottage Wells have about 10 gr. of magnesium sulphate and but little common salt: the Lansdowne Terrace Well has much salt, and some soda sulphate, but little magnesia. The Cambray chalybeate has nearly 1 gr. of carbonate of iron. Some of the springs have traces of iodine and sulphur compounds. Cheltenham Salts are extracted in powder form and sometimes ordered.

Such waters are suitable for cases of dyspepsia with constipation and liver disorder, also for some gouty conditions. The climate is a good one for chronic bronchial and laryngeal affections, as well as for "old Indians," or others returning from tropical climates.

Leamington, near Warwick, on the river Leam, is a handsome, clean and pleasant town with well-kept public gardens, and a fresh, rather moist climate, mild but less relaxing than that of Cheltenham. Of the cold mineral springs, the Pump-room, Nos. 1 and 2, contain 80 to 90 gr. of sodium chloride in the pint with 7 to 12 gr. of magnesium sulphate, about 20 gr. of sulphate, and some carbonate and chloride of calcium, a little carbonic acid, no sodium sulphate (Brazier Hake). Aylesford's Well has about 12 gr. of this salt in addition, and the chalybeate with similar ingredients has upwards of a grain of carbonate of iron; other analyses give traces of iodine, bromine, and sulphuretted hydrogen; for an aperient effect 10 to 20 oz. must be taken. The Montpellier baths are well arranged, and include vapour douches and medicated vapour baths. A course of Leamington waters and baths (for which the arrangements are good) is often serviceable in cases of dyspepsia and hepatic congestion with constipation, hæmorrhoids, etc., also in chronic rheumatic and gouty conditions, lumbago, sciatica, eczema and other cutaneous complica-

tions, pelvic disorders of women, anæmia, chlorosis and at the climacteric period. The value of the calcium chloride, especially in strumous disorders with glandular enlargements, bronchocele, tonsillitis, and even in tubercular joint disease is often apparent.

Brides-les-Bains has a good Establishment, Casino and residences, along the borders of a torrent, the Doron, sheltered north and south by vine- and pine-clad mountains, nearly 1,800 feet above the sea, in a Swiss-like part of Savoy, within a few hours of Aix-les-Bains. The climate is sub-Alpine and glaciers are in the neighbourhood. The springs are warm (90° to 95° F.) and contain of sodium sulphate in the quart about 15 gr., nearly double that quantity of chloride, half that amount of magnesium and an equal amount of calcium sulphate with some iron and free carbonic acid. This combination has been compared, though weaker, with some of the Carlsbad springs, and Brides has been termed the French Carlsbad; similar cases are sent to both places, especially liver disorders, gall stone, hæmorrhoids, abdominal obstructions, constipation, uterine disorders, migraine and nerve troubles, splenic and other malarial sequelæ, anæmia, rheumatism, gouty diabetes and obesity. Delastre adds cases of eczema, psoriasis, also chronic laryngitis when of "constitutional," *i.e.* gouty origin, and of albuminuria with similar qualifications or when "phosphaturic" or functional. In small quantity the waters are tonic and aperient, in large, purgative and diuretic, which effects are increased by the addition of Salins water or Brides salts if necessary: they are readily digested and can be continued for some length of time without irritating or weakening.

Salins Moutiers, about two miles away and 300 feet lower, finds its place rather among the salt waters, for it has perhaps "the richest existing" (Gubler); the temperature is 95° F. and the supply is so abundant, 1,500,000 gallons in twenty-four hours, that they have been termed "a hot sea in the Alps." There are 240 gr. of salts in the quart, common salt being estimated at 1 per cent., with sulphates of sodium, magnesium and calcium, traces of iron, arsenic, lithium, iodine and bromine and sufficient carbonic acid to keep the warm waters bubbling and sparkling as they flow constantly through the baths. These are used for chronic rheumatism and arthritis, genito-urinary disorders and all forms of debility, defective nutrition, rickets, anæmia and

some cardiac disorders. Now that a railway station is opened and a new establishment built, these powerful waters, in beautiful scenery and with mountain air, are certain to be more sought after.

Grenzach, near Basle, 920 feet above the sea-level, has cold, still, sulphated chloride waters, used for dyspepsia and liver disorders.

CLASS 5.—MURIATED OR COMMON SALT WATERS.

Homburg, about nine miles from Frankfort, pleasantly situated on the southern slope of the Taunus Mountains, 600 feet above the sea, has a fresh and bracing climate even in the summer, though the growth of trees and of houses has made some portions less fresh. There is beautiful surrounding scenery with walks and drives in the wooded hills, a magnificent Kursaal and park, a fine bath establishment and all forms of amusement and recreation, especially in the open air. The five springs are cold (50° F.), three are classed as "resolvent," the celebrated Elizabethenbrunnen containing 75 gr. of sodium chloride (1 per cent.) in the pint, the Kaiser with 55 gr. (compared with the Kissingen Rakoczy), and the Ludwig which may be considered as No. 1 diluted one half; all these contain in addition other alkaline chlorides, lime, magnesia, lithia and iron carbonate, with a large proportion (especially in No. 2) of carbonic acid, which renders them pleasantly sparkling. The other two—the Stahlbrunnen (one of the strongest chalybeates in Germany, with about $\frac{3}{4}$ gr. of iron bicarbonate in the pint) and the Luisen, which ranks with the principal spring at Schwalbach, are classed as tonic; the former contains also rather more salt than the Ludwig, the latter about half as much, with other chlorides, etc., much carbonic acid and a trace of sulphuretted hydrogen.

The direct effect of such waters is to promote appetite, secretion of gastric juice and other glandular secretions, peristaltic action of the bowels and diuresis—the excretion of urea is said to be increased 25 per cent. The indirect effect is to promote absorption and assimilation. The resolvent group are given in chronic catarrh of the stomach and bowels, habitual constipation, hæmorrhoids and other rectal affections, congestion and engorgement of the liver, and some cases of diabetes, as well as in obesity and

especially in gout and in the uric acid diathesis, when Carlsbad waters might be too strong. Chronic rheumatism, women's diseases, and respiratory catarrhs are also treated at Homburg and the *saline* iron springs are sometimes more effective in anæmia, debility, etc., than pure chalybeates such as at Pyrmont.

The Soolsprudel and the Landgrafen have been recently reopened for bathing, and the large amount of chloride and of carbonic acid in the former, cause it to be much used in cardiac cases. The spa is open all the year; the season is from 1st May to 1st October.

Kissingen is a clean, pleasant, country town of Bavaria in the open valley of the winding Saale, with fine hotels and establishments, a beautiful Kur-garten, high-class music and all the resources of a fashionable, much-frequented spa. The reading room is specially good. The wooded hills which surround it furnish charming shaded walks which are marked with measured altitudes for a "terrain-cur" (Oertel). The air is pure, the climate mild, "tolerably uniform," in summer decidedly hot, the shelter from north and east rendering it more so than many places farther south.

As contrasted with Homburg and Wiesbaden it is the main representative of cold moderately strong gaseous salt springs; there are three of these which rise near together in the Kur-garten, very similar in their composition but differing in concentration. One of world-wide repute—the Rakoczy—bubbles up clear and sparkling (from carbonic acid) and has nearly 45 gr. of sodium chloride in the pint with 2 of potassium and of magnesium chloride, nearly 5 of sulphate of the same, 3 of sulphate and 8 of carbonate of lime, about $\frac{1}{2}$ gr. of iron carbonate, and less than half that amount of lithium. Its temperature is 50° to 52° F., and it is usual to stand the glass of it in tables formed to hold hot water, until it is warmed, then the gas escapes and after a time the brownish iron oxide precipitates; thus warmed it is more suitable for gastric catarrh, but is sometimes less purgative as it is less irritant. One or two glasses are generally efficient, but sometimes four or even six are taken in the early morning, or in divided doses during the day.

The Pandur Spring has slightly less iron and chloride and a more pungent and agreeable taste. The Max, with less than half

the amount of salt and sulphates, is used more as a table water or as a diuretic. The purgative effect is sometimes increased by the addition of "bitter water" prepared from a formula of Liebig's representing Friedrichshall water. The same authority advised whey as a diluent, and a few ounces of this are still sometimes used as a laxative, and to promote secretion in chronic respiratory disorders (with the Maxbrunnen),—larger doses, $\frac{1}{2}$ to 1 pint, may excite diarrhœa. In cases of anæmia and debility, the chalybeate from the neighbouring Bocklet is added, or taken later in the day.

For baths the Pandur or Schönborn are used; the latter has 88 gr. of salt in the pint and the Soole Spring (for which there is a separate bath house about twenty minutes from the town at the Saline on the banks of the river) is nearly as strong. It shows the curious sight of a roaring foaming body of water rising for a few minutes, giving off great quantities of carbonic acid (which is collected in a glass cylinder for baths) and then sinking to rest for a time unruffled and dark. These waters are also pumped to the top of thick and lofty walls of dried boughs, whence they trickle down, impregnating the neighbouring air with salt spray, whilst patients walk alongside as at Reichenhall; they are used also in inhalation rooms. In the baths themselves, heating is effected as the water is admitted by means of steam in coiled tubes, so that most of the gas is retained, and a specialty is the Wellenbad, where a jet of the cold mineral water pours up from the bottom of the bath, producing powerful wave strokes and at the same time cooling the bath to any temperature.

With all such resources Kissingen is a spa most valuable in many disorders, *e.g.*, in chronic gastric catarrh, with deficient acid and pepsine, flatulence, eructations, constipation or diarrhœa, often with more or less dilatation when lavage of the waters is employed; in congestion and enlargement of the liver, with abdominal plethora, gall-stones or hæmorrhoids. Tape-worm is said to be well treated by a course of the waters (preparatory to purgatives which have failed to cure previously), also nervous disorders, hysteria, hypochondriasis, sciatica, migraine, and especially "nervous dyspepsia" which is so frequent an accompaniment of neurasthenia, etc. In such cases, according to Ewald, whilst common salt waters scarcely ever injure the general health, the Glauber's salt (sulphated) waters of Carlsbad and Marienbad often

increase irritation and depression and are "fraught with danger in gastric neuroses." Diseases of the throat and chest, catarrhs, emphysema, pleuritic effusion, corpulence with fatty heart, uterine catarrh, metritis, parametritis and disorders of menstruation, gout, rheumatism and secondary peripheral palsies, as well as tuberculosis, rickets and glandular enlargements (for which there is a special children's hospital) and impetiginous eczema, urticaria, and psoriasis are included in the long list given by Dr. H. Welsch in his brochure on Bad Kissingen.

The waters may be taken all the year round, but the baths and the principal amusements are limited to the season, May to October.

Wiesbaden, capital of the former Duchy of Nassau, is 323 feet above the sea, and is situated beautifully on the southern slope of the Taunus Mountains, five miles north-west of Mayence. The climate here is mild, in winter being one of the best in Germany, in spring and autumn usually fine, but at midsummer hot and relaxing, and mosquitoes are apt to be troublesome. The season is from June till September, also in the winter, and the attractions of a large and agreeable residential city are always available. There are fine hotels, many with their own mineral water baths on the ground floor, theatres, museums and art collections, a splendid Kursaal with lake and gardens and famous music; avenues of trees in the streets and easy access to wooded walks on the Taunus Mountains, and by "funiculaire" now to the Neroberg (over 700 feet). The principal spring is the Kochbrunnen, which rises like a boiling well, at 150° F., emitting clouds of steam. Its constituents are similar to those of the Kissingen Rakoczy, *viz.*, chloride of sodium (52 gr. in the pint), carbonate of calcium (3 gr.), and traces of lithium, potassium, magnesium, iron, bromides, iodides, etc. The amount of carbonic acid is much less (6 cub. in.); the temperature much higher. The so-called "Wiesbaden gout water," imported in bottles, is prepared from this spring, the principal addition being about 65 gr. of sodium bicarbonate in the pint. The amount of chloride is slightly greater than that at Kissingen, but yet larger doses of the water can be taken, and increased intestinal secretion less often occurs from it. Hence, if the gastric condition does not especially need the stimulus of cold, the warm spring is to be

preferred when the strong effect of salt on the blood is desired. Dr. E. Pfeiffer from experiments on himself found that the Wiesbaden waters produced an increased secretion of urine, much more than could be simply explained by the larger quantity of water ingested. This increase of urine, with which is associated increase in the amount of urea excreted, is especially noteworthy if the water be taken in one dose in the morning (Record, 1882).

Besides the other drinking waters—Adler, Wilhelm, and Schutzen—which are weaker in composition except as to calcium and lithium, there are upwards of twenty-four used for baths, so that the supply is very abundant, and has been so since Roman times; a thin scum forms on the surface after standing, and a slight smell of sulphuretted hydrogen is perceived.

In cases of chronic inveterate gout which we can scarcely hope to cure, but which we can benefit by moderate increase of tissue-change whilst keeping up nutrition, these springs are most useful; also in chronic eruptions and ulcerations, glandular enlargements, neuralgia, sciatica, hepatic and abdominal congestion, and in chronic rheumatism, in which disorder and in chronic peripheral paralyses, or from spinal meningitis, the warm saline baths are specially indicated. They may be injurious in debility, and in the presence of a tendency to apoplexy or other hæmorrhagic conditions.

Forms of catarrh, gastric, intestinal, bronchial and laryngeal, are successfully treated at Wiesbaden—for the latter, spray and inhalation rooms are available. Chronic inflammatory pelvic disorders have baths as at Kissingen, and syphilis is managed specially as at Aix-la-Chapelle. There are several large hydros, a “Naturheilanstalt,” and the fine Augusta Victoria Bad with all modern forms of bath, massage, electricity, etc. Milk, whey and grape cures are well carried out, the latter being recommended in the autumn after a course. **Salzschlirf**, which is becoming more known, and **Kiedrich**, both in Hesse-Nassau, have waters of similar type with more lithium.

Baden-Baden, “unrivalled for natural beauty,” lies at the north-west of the Black Forest, 650 feet above the sea, on the right bank of the Oos, and ascending in terraces the ridge of the Castle Hill, which looks over cultivated plains to the Rhine, six miles away. The gardens and wooded promenades, the public

rooms, amusements, etc., are world-famous, the Friedrichs and Augusta bath houses are amongst the finest in Europe. Owing partly to the shelter of the hills north and north-west the climate is mild and equable with moderate moisture and slight currents of air, so that it is soothing to nerves and mucous membranes, whilst it favours the functions of the skin. In July to mid-August it may be very hot, therefore the fashionable season is later, and bathing is prolonged till the end of October; then and in the spring it is an intermediate station for invalids from north to south, or returning, and it has also a winter season of its own, thus being open all the year.

The springs, twenty in number, are hot, 124° to 150° F., and not strongly mineralised except the Brühquelle which is for salt baths. The Ursprung, used most for drinking (Weber says the Hauptstollen), has only 36 gr. of sodium chloride in the quart, with a few of lime, magnesia, etc., and traces of arsenate of calcium or iron. The amount of contained carbonic acid is small.

The Ungemach, Felt and others have also from $\frac{1}{3}$ to $\frac{2}{3}$ gr. of chloride of lithium, for which they are in much repute as being amongst the strongest known, though the dose taken can only be minute: for purgative effects a sulphated water is generally added. The waters are clear, soft, greenish and where they flow in the open, show green concretions of algæ, and ochreous ferro-silicic deposit; they are largely used for chronic gout and rheumatism especially in the delicate; for dyspepsia, catarrhal and "nervous"; for emphysema and chronic bronchial disorders, for which there are inhaling and compressed air chambers; for some heart affections, obesity, etc., for which a "terrain-cur" is marked; for pelvic diseases, as well as for neuralgia, neurasthenia and early tuberculous (glandular) complaints and exudations, articular affections and tabes. As at Wiesbaden, there are many private sanatoria.

Baths as at Wildbad are available, with sandy floor and through-flowing stream, as well as all other forms of bath and exercise.

Soden, about nine miles from Homburg, situated in a quiet valley, 440 feet above the sea, amidst vineyards, rose gardens, meadows and trees, contains many tepid salt springs varying in

their proportion of chloride from 18 to 109 gr.; the amount of carbonic acid is large, especially in the Champagner Brunnen.

The climate is mild, equable, and moist, but hot in summer, not bracing. Besides being suitable for the class of cases already mentioned, Soden has a special reputation, mostly amongst Germans, in chronic catarrhal conditions, with or without tendency to phthisis: much of the day can be spent in the open air, for which purpose hammocks are slung from trees. There is a good bath and inhaling establishment. Near at hand, at Kronthal and Neuenhain, are good chalybeate springs, and the bracing health resort of Falkenstein, which is 1,700 feet above the sea, well wooded and sheltered from excessive sun and wind, and forming a good residence both in winter and summer for the earlier stages of phthisis—better, perhaps, than Soden.

Reichenhall, in Upper Bavaria, lies in a high sheltered position, near fine Alpine scenery, and has a mild but bracing climate, which is at its best in May and autumn, being rainy in the summer. Of its salt springs, the Edelquelle is one of the strongest in Europe, containing 23 per cent. chloride of sodium, with a little bromide, magnesia, etc.; its temperature is 57° F. The waters are used in warm, tepid, douche and wave bath, and also by inhalation, patients walking between large hedges, 40 feet high, made of twigs, on which the salt water trickles and evaporates; the air of a large room is also kept impregnated with salt spray, and the breathing of such air for a limited period daily is found useful in catarrhal conditions of the chest and stomach (Sanderson, Pract., vol. i.).

This spa, the centre of the Bavarian salt works, has now become one of the most important and frequented in that country, and is used as a summer station by many who have wintered in the south. It has added to its resources all forms of mud and pine baths, and pneumatic treatments, etc., for tuberculosis, rheumatic and gouty disorders, exudations, asthma, anæmia and debility, and is one of the best-known resorts for the "terrain-cur" in heart disease and obesity. Berchtesgaden and Rosenheim in the same region have also salt baths and are climatic health resorts—the former is "very beautiful, but too much shut in by mountains to be called bracing" (Weber).

Kreuznach, in Rhenish Prussia, pleasantly situated in the

Nahe Valley, 286 feet above the sea, "is the chief of sool baths" (Braun), although only developed since 1831.

The fine modern Kurhaus and park are on "Bath Island," as are also many hotels and pensions, and the well-built new town, Bad Kreuznach, with its separate station, extends along the right bank of the river Nahe, which falls into the Rhine at Bingen, ten miles away. The hills near have more vineyards than woods. The climate is mild and dry, *i.e.*, with moderate rainfall and free from fog; in summer it is very hot, yet the mid-season is from June to August 15th; most of the hotels and many houses have their own baths, so that they are available all the year.

The Elisenquelle contains 73 gr. of chloride of sodium, 13 gr. chloride of calcium, 4 gr. chloride of magnesium, traces of potassium, lithium, iron, and minute quantities of bromide and iodide of magnesium; there is some carbonate of calcium but no sulphate; no carbonic acid; temperature, 54.5° F.: it readily acts on the bowels. The water of the Carlshalle and Theodorshalle is weaker, the chloride of sodium being 59 gr. and 57 gr. respectively, whilst the Oranienquelle has 108 gr. of the sodium salt, and 22 gr. of chloride of calcium. The waters, which are bitter and rather nauseous, should be commenced in small doses, and are often taken with hot milk.

The warm baths at Kreuznach are used particularly strong, concentrated brine, or "mother-lye," being often added to the natural water, and the bath being prolonged for half an hour or an hour. This "mother-lye," according to the degree of its concentration, contains in each pound from 100 gr. to more than 200 gr. of chloride of sodium, from 1,000 to 2,000 gr. of chloride of calcium, from 200 to 300 gr. chloride of magnesium, 130 to 160 gr. chloride of potassium, some iodide of sodium, chlorides of lithium and aluminium, and about 60 gr. of bromide of sodium.

The justly esteemed Kreuznach system of treatment combines the use of these strong baths with injections, douches, etc., and drinking of the water—in small quantities if a generally stimulating effect is desired, but in large doses for the absorption of tuberculous and other exudations. I have seen much advantage from it in congestion and chronic inflammation of the uterine system, in hypertrophy and induration of the uterus itself, and of the mammary gland, and in painful irregular menstruation

connected with ovarian hyperæmia. It relieves, also, the local congestion and œdema commonly associated with uterine fibroma, and may, I believe, induce partial absorption.

Besides the cases mentioned, affections of the lymphatics and of mucous membranes, of the eye and ear and the skin are sent to Kreuznach, much value being attached to the calcium chloride in such cases. The Victoria Hospital receives large numbers of children for strumous disease and rickets. Catarrh of the respiratory tract is treated as at Reichenhall and at the neighbouring Münster-am-Stein by inhalations of spray at "Gradirhäuser" and in rooms. Prostatic and vesical cases, rheumatic and gouty sequelæ are benefited, and the local use of the "mother-lye" to distorted joints has sometimes given good results. Finally, as is the case with most salt springs, some cases of chronic nerve disorder, of chronic heart disease and obesity, do well.

Similar cases are treated at **Bad Nauheim**, a small clean well-planted town at the foot of the Johannisberg (Taunus), 400 feet above the sea, and about forty minutes by express from Frankfurt, twelve miles from Homburg. There is a fine Kur-Saal, dating from the time of gaming tables, and a large park with a lake, etc., also long shaded walks on the level, as well as climbing exercise (Terrain-cur). The air is pure and fresh even in summer.

It is only about fifty years ago that first the Great Sprudel and then the Giant Sprudel came to the surface and Nauheim began to rank amongst the important salt baths. Thirty years ago F. W. Bineke drew attention to good results in nervous and spinal disorders and chronic heart disease; and later the Brothers Schott developed the "Nauheim treatment" specially for such cases, and the spa has become one of the most interesting and important in Europe. The two springs mentioned which are used for baths contain 400 gr. and upwards of sodium chloride in the quart (2 to 3 per cent.) with about 30 of calcium chloride, 15 of bicarbonate and small quantities of other alkalies and earths, and a large amount of carbonic acid at a temperature of about 90° F. The baths are given at varying temperatures and force of current, simple, *i.e.*, deprived of the gas, effervescent with the natural gas, and effervescent current (Sprudel-strom) in which water flows direct from the spring constantly through the bath, and with an extra quantity of carbonic acid; this is highly

stimulating and is special to the place. Of the springs used for drinking, the Kur-Brunnen and the Karls at 70° and 59° F. respectively have about 1 per cent. or $1\frac{1}{2}$ of chloride of sodium and 15 gr. of the calcium chloride and bicarbonate in the quart with much CO₂. The Ludwigs and Schwalheimer Brunnen are weak enough for use as diluents or as table waters in dyspepsia—the latter is chalybeate.

Whilst rheumatism, tuberculosis and exudations dependent on them or on other inflammations are largely treated at Nauheim, its special reputation is for chronic affections of the heart and circulation. The baths increase elimination by the skin and kidneys, reduce the heart-frequency and quiet its action, lessen the respiration rate and improve its capacity, congest the skin and dilate peripheral vessels; it is this last effect which is presumed to save cardiac energy whilst the conjoined “resistance-exercises” afterwards aid in restoring tone to the organ. Much importance is attached to graduating the baths,—if commenced too strong, undue stimulation and restlessness occur. Still water at 92° F. with 1 per cent. salt for six or eight minutes is usual to begin with, and this should be followed by rest in warm sheets for an hour or two, and complete intermission every three to four days. As the heart action improves, stronger salt and gas are introduced, whilst the temperature is lowered 5 or more degrees.

Remarkable improvement has been recorded in cases of hypertrophy and dilatation, idiopathic and secondary to long standing valvular disease, and accompanied by dyspnoea, more or less angina, sometimes anasarca, sometimes with sclerosis and cerebral attacks or asthma, nephritis or diabetes.

The treatment of emphysema and lung complications is helped by salt spray (Gradir-werke) as at Kreuznach. It is scarcely necessary to add that hot bath treatment in heart disease requires great care, and probably most of us have seen cases where by exhausting the patient it has done harm; in judicious hands it is, however, a valuable addition to our resources. The use of digitalis is sometimes combined with it.

Rehme, now better known as Rehme-Oeynhausen (the latter being the name of the newer part of the town), lies in an open fertile valley along the Werra, within two hours of Hanover, 230 feet above the sea, and has a mild but fresh climate, fairly

uniform. The three warm springs, Bohrloch I., II., III., at a temperature from 77° to 91° F., are highly mineralised, containing from 460 to 500 grains of salt in the quart, with upwards of 40 of sulphates of sodium and calcium, and nearly 1,000 volumes of carbonic acid; these are also strong, cold salt waters, and by mixing these and heating, graduated baths can be given very much as at Nauheim. The same kind of cases are sent there, scrofula, gout, neurasthenia, retarded convalescence after fever, fractures, etc.; heart disease is not made such a speciality, but spinal complaints perhaps more so, such as "spinal irritation," locomotor ataxy, meningitis and some forms of paralysis.

Rehme has a fine Kurhaus and inhalation hall for salt spray in catarrhal conditions of the respiratory tract. There are also carbonic acid baths, and a wave bath in the river.

Rheinfelden, an old town near Basle, high on the borders of the Black Forest, has salt waters said to be the strongest abroad, containing upwards of 30 per cent. like Droitwich; they are used in baths for the scrofulous and rickety, as well as for absorption of pelvic and pleuritic exudations.

Bex is another high Swiss salt bath (1,400 feet) in the Rhône valley near St. Maurice and under the Dent du Midi, with fresh mild climate but very hot in summer. Besides the small town, where there are salt factories, and baths in the hotels and lodgings, there is a fine establishment, Grand Hôtel des Salines, 200 feet higher, in an extensive wooded park with all hydropathic resources, grape- and whey-cures; the waters include a cold, strong saline (15 per cent.), with other chlorides and some sulphate of calcium and magnesium; a concentrated "mother-liquor" very strong in alkaline and earthy chlorides—about 12 per cent. of magnesium chloride alone—with much sodium sulphate, etc.; and a medium saline with calcium sulphide and sulphuretted hydrogen. Chronic gout and rheumatism, tuberculous or glandular disease, liver and uterine disorders, abdominal plethora, etc., are treated here, but catarrhal cases mostly. The salt "mother-lye" is in use also at the neighbouring Baths of Lavey on the banks of the Rhône, which are much frequented by French and Italians as well as Swiss, for similar cases and for skin diseases. There is here a special spring not easily classed unless as mixed sulphurous, weakly mineralised with sodium chloride, sulphate,

etc., and fairly large amounts of sulphuretted hydrogen, carbonic acid and containing nitrogen at a temperature of 112° F. (Suchard); it is easily digested, stimulates and increases all the secretions. The Rhône water is also utilised for hydropathy and the sand for hot baths at 150° F.

Kreuth is another high salt spa (nearly 3,000 feet) two hours from Munich, beyond the Tegernsee; it has also a cold alkaline sulphated water (Kreuzquelle) containing sulphuretted hydrogen. With an Alpine climate, it is sheltered and has a pure, rather moist, particularly *still* atmosphere, so that it is a good “air and terrain-cur,” and walks are indicated in colours according to their ascent. Milk, whey, kephir, herb and other cures are available, as well as baths and waters at the large Kurhaus—which is open only in summer.

Cases of gout and irritable mucous membranes are often benefited, also anæmia and debility.

Hall in Würtemberg, near Stuttgart, at a height of 700 to 800 feet, has cold saline waters made of various strengths by concentration, and is much frequented for strumous disease, etc.; there is also a sulphur spring.

Bad-Hall in Upper Austria (1,000 feet) has a noted “Iodine water” with a good proportion of sodium chloride and $\frac{2}{3}$ gr. iodide and rather more bromide of magnesium; also other salt springs. Besides tuberculous cases—for which there are hospitals—diseases of women are sent here.

Hall in Tyrol—1,700 feet—has a much stronger brine, 24 per cent., supplied from the neighbouring Salzberg; iron and sulphur waters are available near.

Ischl, a spa very popular in Austria, is beautifully placed 1,500 feet above the sea at the junction of the river of the same name with the Traun, and has mild salt waters for drinking, strong for bathing, a salt sulphated water with sulphuretted hydrogen, moor and pine and hydropathic baths and a terrain-cur.

Dürkheim in the Palatinate, at the entrance to the Isenachthal (altitude 380 feet), has saline bromo-iodurated waters like those of Kreuznach, but weaker; also grape and whey cures.

Salzungen, near Eisenach in the Werrathal, 780 feet in altitude, has saline waters of graduated strength from 3 to 25 per cent.; a “mother-lye” is prepared containing a very large amount

—47 per cent.—of magnesium chloride with 30 gr. of bromide and 15 of iodide of the same in the quart; moor baths and also inhalations are available.

Cannstadt (and Berg) form a suburb of Stuttgart and have about forty saline and chalybeate springs of varying strength, cold and containing carbonic acid, used as baths and for drinking in various forms of catarrh, debility, etc. The Wilhelmsbrunnen has 30 gr. of salt to the quart with sulphates, etc. There is a Kursaal and also a well-known sanatorium for nervous, and another for cutaneous disorders. Being in the valley of the Neckar the climate is mild and sheltered, though the altitude is 600 to 700 feet.

This class of waters is not met with so often in France, but is represented at **Bourbonne-les-Bains**, which has been termed the French Wiesbaden. It lies on high ground (900 feet) near Vesoul, with fine views of the Vosges. The waters are hot, 120° to 150° F., and contain with free carbonic acid, 75 gr. of salt in the quart with some sulphates, chlorides and bromides, and traces of iron, iodine and arsenic. They are used especially in bath and douche and with electrical treatment in chronic rheumatism, sciatica and forms of paralysis; also in scrofula, bone disease, gunshot wounds, etc., for which there are civil and military hospitals, and in some cases of gastric catarrh, gout and syphilis (cutaneous). There are chalybeate and earthy springs near.

Lamotte-les-Bains, near Grenoble, 2,000 feet above the sea, has also warm saline waters 140° F. with about 50 gr. of salt to the quart, and a few of alkalies and alkaline earths, which are used for rheumatism, tuberculosis and pelvic disorders.

Balaruc, near Montpellier and the salt lake of Thau, has a strong brine, over 100 gr., with a little bromide, at a temperature of 118° F. (Source des Romains), with others weaker and cold, and salt mud baths, used in similar cases to the last, and in paralysis.

Salins, near Dôle, 1,200 feet above the sea, in a mountainous district, is the seat of large salt works and a much-frequented establishment with cold strong waters, containing nearly 400 gr. of salt to the quart with some bromide and iodide; a mother-lye is also prepared very strong in the same as well as in chlorides and sulphates, from which similar cases benefit.

Ischia in the Bay of Naples has upwards of twenty warm saline alkaline springs, many of which are weak enough to be classed as "indifferent".

Cappone Fontana is a "cold Carlsbad," where vapour, sand and sea baths are available. **Casa Micciola** is used for rheumatism, gout, paralysis and uterine disorders.

Castellamare, celebrated for its beautiful position on the same bay, has a saline spring with 75 gr. of salt and 15 of calcium bicarbonate: also a chalybeate and a sulphur spring utilised in cases of liver, spleen and glandular disorders, and cutaneous and urinary affections.

Monte-Catini, another "Carlsbad of Italy," is beautifully placed in the Val di Niévole, near Lucca, 920 feet above the sea, and has good establishments and salt springs (thirty-six) of varying strength up to 300 gr. in the quart, at temperatures of 70° to 90° F.; used for dyspepsia, rheumatism, diseases of women, etc. La Toretta spring is purgative and is used in hepatic disorders, and is exported.

Abano, near Padua, 100 feet higher, contains hot—up to 200° F.—not strong saline waters, with some bromide, iodide and lithia, which are used in conjunction with strong mud baths, electricity, massage, etc., in rheumatism and gout, ovarian and uterine inflammations, scrofula and late syphilis.

Salsomaggiore, near Milan, has recently become better known in England, and is now much frequented and easily reached from the railway between Milan and Parma. The village lies in an open cultivated valley 520 feet above the sea, at the foot of the Apennines. The cold muriated iodo-bromine waters are obtained in ample quantity from Artesian wells, clear at first but soon becoming brown by oxidation, and having greenish-black petroleum on the surface, and so much gas that it is stored for use.

They are richer in iodine and bromine than any similar waters known (Eyre), containing these elements in combination with magnesium—1 to 3 gr. in the quart—nearly 2,000 gr. of sodium and 200 gr. of calcium chloride, besides some chloride of lithium, magnesium, ferrum, etc.; from this a mother-lye, "acqua-madre," is prepared by evaporation, and contains still larger proportions of magnesium and calcium chlorides. The treatment is conducted mainly by baths of various strengths and temperatures of water

or mud, and by inhalations as well as by massage and electricity, and has proved efficacious in chronic glandular and other tuberculoses and syphilis, subacute and chronic arthritis, rheumatism and gout, laryngitis, bronchitis and rhinitis, neuroses and exudative diseases, peritonitis, appendicitis, metritis, etc., also in anæmia and debility after illness. There are good hotels with baths, open from April to November. July and August are liable to be hot and crowded.

Droitwich is a small salt-manufacturing town, six miles north of Worcester, and fourteen from Malvern. The climate is mild and equable, rather relaxing, and though the place itself is uninviting, there is fine open country in the immediate neighbourhood. There is now good accommodation for bathing, and an establishment close to the waters.

The proportion of saline ingredients is very high—far higher indeed than at any other known spring (except Rheinfelden), there being about 2,500 gr. chloride of sodium, 38 gr. calcium sulphate, and 39 gr. sodium sulphate in each pound (D. T. Taylor). Used for bathing at about 95° to 112° F., these waters are stimulating and absorbent, and are very serviceable in relieving pain and exudations, and impaired power connected with chronic rheumatic and gouty conditions; also in lumbago and sciatica, in some chronic skin eruptions, in glandular scrofulosis, general debility after illness, etc., especially when this is associated with slow circulation and mental depression; serous effusions are also absorbed under their use, and they are said to have proved a powerful stimulant and restorative during the cholera epidemic of 1831. Strong brine baths can be used at a high temperature without the exhaustion and debility that follow an ordinary hot bath. Dr. Roden states that the best results are obtained from the water when it is diluted two or three times, before being used as a bath. The patient sweats a great deal on the portions of his body which are not submerged,—for instance, over the head. Languor is felt for an hour or so after a bath, but is followed by a feeling of exhilaration, accompanied by an excellent appetite. Dr. Roden also speaks very positively concerning the absorption of local gouty deposits during a course of baths at Droitwich; possibly, he thinks, due to the chemical influence of the water on the concretions.

Woodhall Spa, in Lincolnshire, has a dry and bracing climate, and is sheltered from north and east winds; there is a hotel in the grounds, with excellent baths and lodgings in detached houses, well suited for invalids. The water contains a good proportion of sodium chloride (120 gr. in the pound), 21 gr. of calcic and other chlorides, and also about $\frac{1}{2}$ gr. of bromide and $\frac{1}{2}$ gr. of iodide of sodium. It is used in strumous disease, also in chronic gout and rheumatism, and in catarrh of the respiratory and digestive tracts; it may be used in spray; half a pint of it acts as a mild aperient; the salts are crystallised and exported. Mr. Williams reports satisfactory results also in cases of chronic skin disease, leucorrhœa, and uterine fibroids, etc., such as are usually sent to Kreuznach, the waters of which spa it will be seen are similar.

There is a saline spring at **Harrogate**, somewhat similar to one at Kissingen, and called the "Kissingen water." It has more lime and less carbonic acid, and is moderately aperient. Most of the sulphur waters also contain a large proportion of chloride.

CLASS 6.—CHALYBEATE WATERS.

The comparatively pure iron springs, that is, those with little else but the iron salt, are: Schwalbach, Spa, Brückenau, Schandau, Liebwerda, Flinsberg, Freienwalde, Recoaro, Königswarth, Liebenstein, Altwasser, Alexisbad, Muskau, Tunbridge Wells, and one spring each at Harrogate and Strathpeffer, Brighton and Flitwick. Iron springs containing in addition a moderate quantity of other salts, especially the carbonates and sulphates of calcium, sodium, and magnesium, and sodium chloride, are: Aratapak, Kniebis (Rippoldsau, Griesbach, Antogast and Petersthal), Orezza, Pyrmont, Driburg, Bocklet, St. Moritz, Reinerz, Godesberg, Cudowa, Imnau and Santa Catarina.

Ferrous carbonate is contained in a large number of mineral waters, in amount varying from mere traces to several grains in 16 oz. It is a truism that minute quantities of iron taken at mineral springs, with the advantages of change, pure air, and often an elevated situation, produce effects as good as, or better than, can be obtained from medicinal doses administered in the ordinary manner. If 0·5 gr. be taken as an average proportion

in 16 oz., then only this amount, representing but 0.14 gr. of metallic iron, is taken with each pint; but when once the condition has begun to improve, the iron contained in *food* is better assimilated, so that improvement is continued by natural processes. A few cubic inches of carbonic acid suffice to keep the iron salt in solution, but on exposure to air part of the acid escapes, oxygen is absorbed, and ferric hydrate deposited. A chalybeate water will keep for some time if not shaken, and it may be heated up to 87° F. without much deposit of iron. A few waters contain sulphate or perchloride.

Of alkaline waters, Gieshübel, Ems, Salzbrunn, Bilin, Luhatschowitz, Apollinaris,—of alkaline saline springs, Carlsbad, Marienbad, Tarasp, Franzensbad,—and of more markedly saline waters, Kissingen, Wiesbaden, Baden-Baden, Soden, Kreuznach, Rehme, Hall, Adelheidsquelle and Harrogate may all be mentioned as slightly chalybeate, and at almost all the great spas there are some pure stronger chalybeates for use besides the saline: the following are amongst those frequented specially for the iron waters.

Langen-Schwalbach, near Wiesbaden, is a pleasant country town with public gardens, a good Kursaal and bath establishment, 950 feet above the sea-level, on a sheltered slope of the Taunus range: it is much frequented, especially by English and Americans, during the summer. Of the several cold springs the Stahl contains in the *quart* as much as $1\frac{1}{3}$ gr. of bicarbonate of iron with traces of manganese and small quantities of alkaline and earthy carbonates, much carbonic acid and very little sulphuretted hydrogen; the Wein rather less than 1 gr.; the Paulinen between these two in strength; the Linden, used mainly for baths, has barely $\frac{1}{6}$; these waters, whilst somewhat astringent, have a special reputation for being easily assimilated, which is traced partly to their large amount of carbonic acid. This also gives much local stimulating effect to the iron-water baths, which are heated by steam so as to expel as little as possible of the gas; the amount of iron in them is enough to stain the skin for a time; peat baths are also given here, often before the iron course; massage and hydropathic treatment, including vaginal douches, are utilised when required.

Schwalbach is largely a ladies' spa for cases of chlorotic anæmia,

genito-urinary catarrh, etc., but it is used also for any cases of debility, slow convalescence, or nervous dyspeptic conditions connected therewith.

Spa, near Liège, beautifully placed in a wooded valley of the Ardennes about 1,000 feet above sea-level, has been for long so famed and fashionable as to give its name to any spot frequented for healing waters. The fine woods are pleasant for shade and scenery but apt to be damp and close in times of bad weather, so that I have known asthmatics unable to remain, but in spring and summer the climate is mostly pleasant and fresh. The cold Pouhon de Pierre le Grand contains from 1 to 3 gr. of bicarbonate of iron in the quart; the Prince de Condé, which is largely exported, rather more; the Barisart less; all have a few grains of alkaline and earthy carbonates and a large amount of carbonic acid, so that they keep for months without any precipitation. Beginning with small doses, the usual modern limit of 30 oz. daily is reached by degrees: it is taken cold but slowly through a tube to avoid a chill, preferably in the early morning and in the open air, though the amount is often divided between morning and afternoon; medicines like iodide or arsenic may be added, and laxatives are often required. The bathing establishment is a very fine one and gaseous chalybeate baths are much employed, especially in the early morning and preparatory to, or together with, a course of waters; for rheumatic, neuralgic or painful cases they are given hot at first and cooler after improvement; the "running sitz" bath, warm, is used for leucorrhœa, etc., a wire speculum being worn, the wet sheet and cold douche come later in the treatment; hot moor baths are available.

Dr. Scheuer differentiates various forms of chlorosis and anæmia suitable for spa treatment, such as that of puberty, of pregnancy, of metrorrhagia, of respiratory and hæmorrhagic disorders, secretory and excretory (from nursing), malarial and from mal-nutrition, etc.; he mentions also hysteria, chorea, rheumatism, bronchial catarrh, atonic dyspepsia, diarrhœa, cystitis and spermatorrhœa. Contra-indications are corpulence in full-blooded persons, abdominal plethora, arterial degeneration and heart diseases.

Brückenau, four miles drive from Kissingen, on a finely wooded mountain slope, nearly 1,000 feet above the sea, has cold, weak, chalybeate gaseous springs, moor baths and douches which

are used principally in female disorders, but the spa is also a good after-cure for convalescents.

Schandau, on the Elbe in "Saxon Switzerland," 400 feet altitude, is a pleasant summer resort with a cold weak chalybeate ($\frac{1}{4}$ gr. of bicarbonate of iron) containing a few gr. of calcium bicarbonate.

Liebwerda, near Görlitz in Bohemia, 1,420 feet above the sea-level, has a rather stronger cold gaseous chalybeate and also an alkaline earthy effervescent water, and moor baths. The climate is said to be rough, moist and changeable.

Flinsberg, ten miles farther south, 1,700 feet altitude, in a pine forest, with bracing air and fine mountain views, has a similar chalybeate, Heiligen-brunnen, with less than a grain of bicarbonate: also a "terrain-cur."

Freienwalde, on the Oder, situated in a fine valley, is a favourite summer resort of Berliners, and has a weaker cold iron spring with less gas, also moor baths.

Recoaro, in a picturesque part of Lombardy, 1,400 feet above the sea, has many chalybeate springs, of which the "Lelia" contains about $\frac{3}{4}$ gr. of carbonate of iron to the quart, with much carbonic acid and a little carbonate and sulphate of calcium and magnesium; near by are the rather strong sulphate of iron waters of Civillina, etc. It is used in female diseases, anæmia, chlorosis, nervous debility, gravel, hepatitis, gall stones, hæmorrhoids and intestinal catarrhs.

Königswarth, near Marienbad, on a wooded hill 2,200 feet above the sea, has besides an "indifferent" water, a cold gaseous chalybeate with more than a grain of bicarbonate, also moor baths. It is a good "after-cure." It is also used for cases of anæmia, scrofula, chronic paralysis, etc., and has a good establishment.

Liebenstein, in Saxe-Meiningen, twelve miles south of Eisenach, is a well-situated and much-frequented spa in the Thuringian Forest, about 1,450 feet above sea-level: it has beautiful gardens, walks and views. Of the two cold effervescent springs, the Alte-quelle contains nearly 2 gr. of bicarbonate of iron with a small quantity of alkali and alkaline earth. The climate is mild and equable and in repute as an air cure. Hydropathy and whey drinking are also available.

Altwasser (1,300 feet), near Liegnitz in Silesia, has noted

effervescent ferruginous waters and moor baths, but it is said they have been interfered with by coal mining within recent years.

Alexisbad, in the attractive Selkethal of the Hartz Mountains, 1,035 feet above sea-level, with fresh rather moist climate and forest scenery, has an Alexisbrunnen, and another with bicarbonate and sulphate of iron, and the Selkebrunnen with chloride and sulphate and also other sulphates used for bathing. Salt and pine baths, douche and massage are also available. The season is not before June and ends mid-September.

Muskau, on the Neisse, between Berlin and Görlitz, has a spa, Hermannsbad, in a famous park and garden with a cold spring, Trinkquelle, said to contain nearly 3 gr. of sulphate, and nearly 4 gr. of bicarbonate of iron and twice the amount of sulphate of calcium, whilst the Badequelle is much stronger.

The arrangements are good, and the cases sent include hæmorrhagic, hyperæsthetic and female disorders. Iron moor baths are also used.

Tunbridge Wells, about thirty miles south of London, 300 feet above the sea, with healthy climate and beautiful environs, has a pure but weak spring, used formerly much more than at present. It contains over $\frac{1}{4}$ gr. of iron oxide in the pint, but little carbonic acid, so that it is not sparkling; it may be taken with advantage in Apollinaris water.

At **Brighton** there is a spring, St. Anne's Well, which contains sulphate of iron in small amount, and at **Malvern**, **Bournemouth**, **Sandown**, and many other health resorts there are chalybeates more or less available.

At **Harrogate**, the Muspratt Spring contains perchloride of iron, with salines—an unusual and effective combination. The Tewit contains 0.135 gr. of carbonate, with a little saline (*v. p.* 284).

Flitwick, in Bedfordshire, has a remarkable spring said to contain as much as 40 gr. of ferric sulphate in the quart with sulphates of alum, sodium and calcium, yet not to be astringent and not to blacken the teeth. It is acid in reaction, of orange colour (from peat compounds), clear, bright, and of pleasant not inky taste; it does not precipitate on exposure, but does so on heating or large dilution. It is bottled for export and is used in moderate doses for anæmia, chlorosis, neuralgia, dyspepsia, debility and rheumatism. There are sulphate springs also at

Trefriw in North Wales, near Dollar and at Moffat in Scotland, and at Lisdoonvarna.

Of the more complex iron waters, a group known as the **Kniebis Spas** at the foot or on the slope of the mountain of that name, in the Wolfthal, or the Renchthal, include Rippoldsau, Antogast, Freyersbach, Griesbach and Petersthal all in the Badisch Black Forest, at elevations of from 1,200 to 1,800 feet above the sea, and possessing cold alkaline or earthy gaseous chalybeate springs. The second one is the oldest, but the first one is now better known and is the highest and most frequented; it lies in a wooded valley amidst wild romantic scenery with parks, gardens, avenues and a good establishment for all kinds of baths. The waters contain from $\frac{1}{2}$ to $1\frac{1}{2}$ gr. of bicarbonate of iron in the quart, with about 15 gr. of bicarbonate of calcium and sulphate of sodium and much carbonic acid; they are made artificial alkaline sulphated waters ("Natroine") by additions which render them more aperient, or sulphurous by sulphuretted hydrogen. They are of service combined with the mountain air, not only in anæmia and its complications, but also in dyspepsia, plethora, hæmorrhoids, hysteria and other neuroses, disorders of glands and mucous membranes, and some forms of gout and rheumatism.

Arapatak or **Elopatak**, 2,000 feet above sea-level, is the principal iron spa in Transylvania, the waters containing bicarbonate with the same salt of sodium, calcium and magnesium.

Orezza, in the mountains of Corsica, has gaseous chalybeate waters containing also a little sulphuretted hydrogen. Cases of anæmia and chlorosis are benefited here.

Pymont, not far from Hanover, in the beautiful valley of the Emmer, 400 feet above the sea, with a healthy, mild climate, and extensive, somewhat old-fashioned arrangements, was formerly the most celebrated of iron spas. It has one of the stronger compound springs, containing $\frac{1}{2}$ to $1\frac{1}{2}$ gr. of bicarbonate with lime, magnesia and free carbonic acid (29 cub. in.). There are also salt springs and baths and ferruginous mud baths.

Bocklet, near Kissingen, 620 feet above sea-level, has a mild climate and a rich saline chalybeate water, which is conveyed to the more famous spa daily: the place is a good "after-cure."

Driburg, near Paderborn, 730 feet elevation, is situated in a pleasant valley, and has a fresh climate. The Hauptquelle has

more than a grain of bicarbonate of iron with 15 of bicarbonate and of sulphate of calcium with much carbonic acid, forming a good earthy chalybeate. The Caspar-Heinrich with even more gas resembles a Wildungen spring. There are good bathing establishments in which effervescent iron, and also sulphurous peat baths are given. Driburg is little frequented.

St. Moritz Bad, in the Upper Engadine, a day's drive from the Coire Station, situated on the lake border in an Alpine valley rich in vegetation, and 5,800 feet above the sea, has become justly popular, for the air is very refreshing and agreeable even to delicate subjects, especially to those of sluggish circulation and unexcitable nervous system. In opposite conditions, it is well to stay first at an intermediate station—anæmic cases with albuminuria do not bear the climate well (Weber). It is clear and dry, and though dew falls, there is little fog or mist; for a winter residence it is also recommended. The springs contain $\frac{1}{2}$ gr. of bicarbonate of iron, with a little soda and lime and much carbonic acid (31 to 37 cub. in.), so that the baths are somewhat gaseous: temperature, 39° to 41° F. St. Moritz Dorf, about a mile from the Bad, is on higher ground (over 6,000 feet) and is more bracing for phthisical and neurasthenic patients.

Santa Catarina, in Upper Italy, near Bormio (5,600 feet), in waters and surroundings and scenery much resembles St. Moritz.

Bad Reinerz, in the Glatzer Mountains (Silesia, 1,820 feet above sea-level), is a favourite watering place with a bracing climate and cold gaseous alkaline earthy springs, containing nearly 1 gr. of bicarbonate of iron in the quart; there are also ferruginous moor baths and walks for a terrain-cur.

Godesberg, a charming village town in a picturesque country ("the seven mountains") four miles from Bonn, has a Stahlquelle with about $\frac{1}{2}$ gr. of bicarbonate of iron and 15 gr. of bicarbonate and chloride of sodium, and a Neuquelle with rather more of the metal: it is a favourite summer resort and has a much-frequented hydropathic establishment; also good bathing arrangements.

Cudowa, in Silesia (about 1,270 feet above sea-level), in the same region as Lieberwerda and Flinsberg, has cold alkaline effervescent springs, the Eugenquelle having nearly a grain of bicarbonate and a small fraction of arsenate of iron with about 20 gr. of

bicarbonate of sodium in the quart; moor and gas baths are available, and the mild fresh climate is good for anæmia, etc.

Imnau (1,140 feet above sea-level), not far from Rippoldsau, has also cold gaseous springs, of which the Kasperquelle contains nearly 1 gr. of the bicarbonate of iron and 20 of calcium with a little manganese. Pine-cone-sap baths are given, and chest cases are specially sent here.

Lamalou, in the south of France (Hérault), 620 feet altitude, is situated in a mountain valley facing the south and has a mild, rather changeable climate. There are three groups of springs, Lamalou-le-Bas, Le Centre and Le Haut, with temperatures of from 59° to 117° F., all more or less gaseous, chalybeate and weakly alkaline. The strongest Source Capus has rather less than a grain of bicarbonate of iron and less than $\frac{1}{10}$ gr. of arsenate of sodium and little gas. The Petit-Vichy has still less iron and less alkali; the De la Vernière, cold and rich in gas, has bicarbonate of sodium, calcium and magnesium, as well as $\frac{1}{4}$ gr. of iron salt. Warm bathing, 88° to 98° F., is a large part of the treatment, several patients often sharing a bath: douche, vapour and massage baths are also given for cases of chronic rheumatism, neuralgia, incipient tabes and chronic neuroses, which were frequently sent here by Charcot. Neurasthenia, syphilitic and paralytic cases, also anæmia and toxæmia are treated here.

THERAPEUTICAL ACTION.—With regard to the therapeutic use of iron waters, formerly invoked so constantly whenever “strengthening” was desired, we must note that more discrimination is now exercised. Sea-bathing, mountain air, quinine, nuxvomica, and other remedies are more used, and iron is ordered more exclusively for true anæmia and chlorosis. Modern medicine, however, recognises anæmia arising from fever, pneumonia, and most acute disorders quite as distinctly as from hæmorrhage. The more rapidly it is produced, and the more directly from loss of blood, or of component parts of blood, as in hæmorrhage, exudation, or suppuration, the greater the indication for iron in full doses; indeed, official preparations are often better in such cases, and chalybeate waters find their use only in later stages.

Their advantages are that they contain a compound (generally a bicarbonate) which is readily digested by the stomach, since it is easily changed into lactate or chloride; that this is well diluted

and so more readily absorbed; and that the free carbonic acid given at the same time is a useful stimulant to the gastro-intestinal membrane. On the other hand, these conditions, under certain circumstances, may be disadvantageous, and a full dose of more concentrated preparations will give better results: for instance, symptoms of *congestion* of the head or chest, under a course of carbonated chalybeate, are referred by many physicians to the carbonic acid rather than to the iron, and in such cases an ordinary pharmaceutical preparation may agree better (Braun).

Simple chlorosis, occurring during the developmental period, seems connected with *direct* loss of iron, and it is in this form of anæmia that the administration of iron proves most successful. It is seen amongst the poorer or the middle classes more frequently than amongst the higher, in whom chlorosis is often complicated with mental excitement or depression, hysteria, leucorrhœa, etc.

The more *indirect* the anæmia—when arising, for instance, from impaired general nutrition, with deficiency of albumin and fibrin rather than of blood-cells, or from special derangement of organs or nerves—the slower and the more uncertain is the effect of iron; the anæmia of mal-nutrition is often better treated by nourishment and hygiene, and even chlorotic anæmia connected, *e.g.*, with hysteria, may be aggravated by iron internally, but relieved by *indifferent* baths as at Schlangenbad.

Anæmia, complicated with or dependent on chronic discharges, such as from caries of bones, diarrhœa, catarrh, etc., is a generally impaired condition of the blood, and should be also treated dietetically, by meat, fat, milk, and with due attention to hygiene. The anæmia of prolonged lactation, which is often accompanied by dyspepsia, requires preliminary medical treatment—weaning the infant being naturally the first indication.

CLASS 7.—ARSENICAL WATERS.

La Bourboule (Puy-de-Dôme, near Clermont-Ferrand), 2,800 feet above the sea on the Dordogne and amidst the finest scenery of Auvergne, possesses a well-known Source Perrière-Choussy, temperature 120° to 130° F., containing about 40 gr. each of chloride and bicarbonate of sodium and the exceptionally large amount of about $\frac{1}{3}$ gr. of arsenate of sodium in the quart, with

carbonic acid sufficient for effervescence. The taste is "like chicken broth." The Sources Fenestres are cold, and much weaker, and are used to cool the baths. The waters are employed also atomised and for inhalation, and have much repute in respiratory disorders. They are also of service in lymphatic and tuberculous diseases and all nutritive perversions of infancy—in the arthritic diathesis and skin diseases, also in tertiary syphilis and cachexia in general. Benefit has also been obtained in diabetes and albuminuria. The waters are exported for use at home.

Mont Dore, four miles nearer the sources of the river, lies in a mountain valley 3,440 feet above the sea. The establishment is open in June when the climate is still cool, and it is a good time to go, as also is August; the season ends in September.

The waters are weakly mineralised with about 10 gr. of sodium bicarbonate and chloride and an appreciable amount of arsenate ($\frac{1}{64}$ gr.) in the quart and about $\frac{1}{3}$ gr. bicarbonate of iron with more or less carbonic acid; the temperature varies from 90° to 116° F.; twelve of the springs have special names, the Madeleine is the principal one exported, the Ramond is strongest in iron. The Sainte Marguerite is a cold effervescent table water.

The cases sent are mainly of disorders of the respiratory tract, nose, throat, larynx, bronchi, early tuberculosis, asthma and emphysema with bronchial catarrh; gouty and rheumatic subjects with spasmodic laryngeal or pulmonary disorders are perhaps most benefited, lymphatic and strumous subjects not so much so, but children do well. Many public speakers and singers go. Inhalations form the chief speciality of the treatment; large rooms are filled with fine steam and spray which patients, suitably clothed, breathe for half to one and a half hour, ventilation being provided for; the vapours hold carbonic acid as well as alkalies, iron and arsenic. These "Salles de Vapeurs" are amongst the finest known, and the other arrangements for bathing and hydropathy are on a corresponding scale; generally douche or foot baths, "partial" and other hot baths are taken in the afternoon, after the morning's inhalation. A "bath fever" is sometimes induced accompanied by a rash or diarrhoea.

Levico, in the Austrian Tyrol, 1,700 feet above the sea, has a fine well-placed establishment and noted effervescent ferruginous waters containing arsenic and copper, which rise at Vetriolo, much

higher up, and are largely exported in two forms, "weak" and "strong." The former contains about 9 gr. of sulphate of iron and $\frac{1}{75}$ gr. of arsenious acid in the quart, and is taken in half or one ounce doses several times daily with meals. The latter has more than 15 gr. of ferric and 30 of ferrous sulphate, $\frac{1}{8}$ gr. arsenious acid, $\frac{2}{3}$ gr. sulphate of copper, about 8 gr. sulphate of aluminium and a little free sulphuric acid in the quart; it is of a dull colour and is given in smaller doses or hypodermically (*vide* arsenic). They are prescribed in anæmia, chlorosis and menstrual disorders, early spinal and other neuroses, malarial cachexia and externally, especially for leucorrhœa and pelvic congestions, whilst besides ordinary hot and vapour, electric light and sun baths are available.

Roncegno, in the same Sugana Valley, at a like elevation on a plateau at the foot of Mount Tesobo, sheltered on three sides, has a mild dry pure mountain air with good hotels and establishments and a water remarkable for its strong mineralisation, containing in the quart $1\frac{1}{2}$ gr. of sodium arsenate, more than 45 gr. of iron sulphates, 15 of aluminium sulphate, and smaller quantities of the sulphate of cobalt, nickel, manganese and copper, besides some alkaline and earthy sulphates, salicylic and arsenical anhydride, and organic matter. It has good repute in the treatment of anæmia, cachexia, struma, neurasthenia and neuralgia, asthma, catarrh, cutaneous diseases, and even Addison's and so-called Graves's or Basedow's disease. For children a teaspoonful is a dose, for others a tablespoonful gradually increased, due digestion and excretion being secured. Diluted it is used in gargle, douche, collyrium, lotion and bath.

There are several other Italian arsenical-iron springs; also Val Sinestra (Grisons) mentioned under Tarasp, and others referred to under Cudowa, Muskau, Vals, Plombières, Vichy, Royat, Vic-sur-Cère (Cantal).

Bussang, in the Vosges, 2,200 feet altitude, has weak alkaline effervescent waters which are chiefly exported and contain carbonates of soda, lime and magnesia, some chloride and sulphate, arsenate of iron and manganese; there is $\frac{1}{50}$ gr. of arsenate of iron in the quart. They are given in anæmia with atonic dyspepsia, and in vesical catarrh, gravel and gout.

CLASS 8.—SULPHUR WATERS.

Under the true sulphur waters are included those containing sulphuretted hydrogen, or sulphides of sodium, calcium, potassium, or magnesium (*v. p.* 284). Some of them, such as Aix-la-Chapelle, Uriage, and Baden (Swiss), contain a considerable proportion of common salt.

The sulphur baths of the Pyrenees have been famous from an early period. Most of them are natural baths (*Wildbäder*), in high mountainous situations, and with a rough climate.

Eaux-Bonnes, department Basses-Pyrénées, 2,300 feet above the sea, situated in a narrow sheltered ravine at the foot of the Pic du Gers, about twenty miles from Pau, is rich in grand natural beauties, and has a pure fresh climate, though it is subject to great changes of temperature during the day.

The waters contain 0.18 cub. in. of sulphuretted hydrogen to the pint and a little sulphur, with but 2 gr. of chloride of sodium, and 2 gr. of other salts, sulphates, and iodides, at a temperature of 90° F. (*Source Vieille*) The dose at first taken is but small, often a tablespoonful, but this is increased gradually to a pint or more, and the good results are said to be so remarkable in tuberculosis and pneumonic consolidation of the lung, in asthma, laryngitis, granular pharyngitis, pleuritic effusion, and scrofulous deposits, as well as in chlorosis, amenorrhœa, and atonic dyspepsia, that many physicians "have supposed the cures to be due to some as yet unknown element in the otherwise very poor water." The *Source Froide* (53° F.) is used more for dyspepsia. The effect is at first excitant, the pulse being quickened, and the appetite and secretions increased, with possibly some malaise and insomnia, but as this subsides improvement sets in (*Weber*). The treatment is not contraindicated in febrile and irritable conditions. The high situation of the spa is probably a main factor in its action. The season lasts from June to mid-September, and residence is usually arranged for a month at a time during one or two seasons. Bathing is not much practised, but the patient is recommended to live as much as possible in the open air, and to complete the treatment by a course of sea-bathing at Biarritz.

Eaux-Chaudes, situated four miles farther on in the same valley, has waters containing a little sulphide of sodium and

sulphate of calcium, which are used more for baths than for drinking, in muscular rheumatism, neuralgia, and chlorosis.

Panticosa, in Aragon, a day's journey from Eaux-Chaudes, is situated in a valley of the Pyrenees, nearly 6,000 feet above the sea. The waters contain much sulphuretted hydrogen, with some sulphide, chlorides and sulphates. There is a "stomach spring" at 84° F. and a "liver spring"; they increase the secretions and the appetite, without stimulating the circulation. They relieve the cough of laryngeal phthisis and bronchial irritation, and are suitable for cases of hæmoptysis, but not for softening tubercle. The best months are July and August.

Cauterets, department Hautes-Pyrénées, 3,200 feet above the sea, a small town in a narrow winding valley, has a pure and fresh but rather variable climate, with cool nights as compared with Luchon. It contains more than thirty warm saline sulphuretted springs, some of which are highly stimulating, and may give rise to feverishness and headache, others are less excitant than most similar spas. The Raillère, which is famous for the cure of chronic bronchial catarrh, contains in one quart $\frac{1}{16}$ gr. of sulphide of sodium, 5 gr. of sulphate, and chloride of sodium, 6 gr. of silica, nitrogen, and traces of sulphuretted hydrogen, but the water is very warm (102° F.). It is used both internally and for bathing and inhalation, and sometimes gives strikingly good results in early stages of phthisis and tuberculous deposit, in gastric catarrh, uterine congestions and fluxes, also in chronic rheumatism and skin diseases. The Thermes des Œufs with a spring at 128° F. is the principal of three large establishments, all very completely equipped. There are also casinos, theatre and promenade. The Source Manhourat (121° F.) is well reputed for dyspepsia and lithiuria, hepatic and splenic disorders; it is for drinking only. There are 30,000 visitors yearly. Animals, especially horses, with catarrh or abnormal discharges are also benefited at Cauterets. July, August and September are the best months.

Barèges, department Hautes-Pyrénées, 4,000 feet above the sea, with a bracing rough climate, is "the most famous of Pyrenean spas." The sulphurous stimulating waters are hot (107° F., *Bain de l'Entrée*), warm (98° F.), and tepid (84°). They are limpid, have an oily nauseous taste and characteristic odour,

and contain nitrogen and sulphuretted hydrogen, with small quantities of sulphide, sulphate, and chloride of sodium, and are more used for bathing than drinking. On their surface is found a gelatinous pellicle called *barégine* or *glairine*, which is a nitrogenous organic substance, found in most sulphur waters, emollient, and supposed to be efficacious in chronic rheumatism. Sufferers from this complaint, and from sciatica, lumbago, and stiffness of the muscles and tendons, visit Barèges in large numbers; it is celebrated also in paralysis, in strumous ulcerations, and especially in bone disease, syphilis, and old gun-shot wounds. The swimming-baths are much used, and the waters are taken internally. They are not suitable for "irritable nervous subjects, nor in heart disease, nor tendency to inflammatory disorder" (Tanner). The season extends from early in June to mid-September. In July and August the crowding is sometimes so great that "invalids must leave their beds soon after midnight for their turns at the baths, and the air in the 'piscines,' from the small space allowed to each bather, is almost intolerable" (H. Weber).

Saint-Sauveur, four miles from Barèges, has similar, but milder waters (Source des Dames), which are much used by women and children for hysteria, neuralgia, leucorrhœa, and uterine derangements—"pre-eminently the French ladies' spa" (Braun). La Hontalade (86° F.) has special repute in gastralgia. The season begins earlier, and lasts later than at Barèges.

Bagnères-de-Luchon, department Haute-Garonne, by the Spanish frontier, 2,000 feet above the sea, is charmingly placed in a broad valley, close to splendid scenery, is largely frequented, enjoys a mild climate (hot in summer), has excellent arrangements for recreation and abundant sulphurous water, double the strength of those already mentioned. There are about fifty springs, varying in temperature from 63° to 132° F., and containing sulphide and sulphate, sulphite, and chloride of sodium, other sulphides, silica, lime, etc., used mostly for baths or inhalation. Analysis detects only traces of sulphuretted hydrogen in the waters at the springs, but almost as soon as drawn they become milky on account of some decomposition, with deposit of sulphur and development of this gas, and so much of it escapes from the large bath that the atmosphere above it contains more than

1 per cent. They are used in the same cases as Barèges and Cauterets. There are also chalybeate and alkaline springs.

Aix-les-Bains, in Savoy, near Chambéry, 790 feet above the level of the sea, in a sheltered picturesque valley of the Alps, is a celebrated watering-place—the *Aquæ Gratinæ* of the Romans—greatly resorted to for its sulphurous springs, which are often of much value in chronic rheumatism, gout, neuralgia, and some skin diseases, as well as in paralysis. The temperature of the water varies from 100° to 117° F.; they are chiefly employed for baths, the douche being most in use. The hot water is made to fall in streams from a height of about 8 to 10 feet upon the patient, whilst being massaged; afterwards he is wrapped in blankets, sent home in a sedan-chair, and then put to bed for further perspiration. The climate is mild and relaxing, but hotels are now built on higher levels where the air is more bracing. During the season the place is often unpleasantly crowded; the course though effective is weakening, and should be followed by mountain air for a time.

Aachen (Aix-la-Chapelle), the most important sulphur saline spa in Germany, has also the resources and the ample accommodation of a large and interesting city, which lies in a valley 534 feet above the sea, sheltered by wooded hills; the climate is mild and rather moist.

There are four principal springs which are of similar composition but vary in proportions and in temperature from 113° F. to 131° F. The *Elisenbrunnen*, which is the most used for drinking and is supplied by the *Kaiserquelle*, contains of sodium chloride about 40 gr. in the quart, with 8 of carbonate, 5 of sulphate and more than 2 of sulphide, with some potash, lime, magnesia and traces of bromides, iodides and iron, together with nitrogen, carbonic acid and sulphuretted hydrogen. When freshly drawn it is clear, colourless and acid to litmus, but after exposure becomes turbid and alkaline, deposits a sediment and loses the smell and taste of sulphur. It is as a rule well digested, gives a sense of warmth and stimulation, increases appetite and secretion, and to some extent the action of the bowels.

Baths are also largely used, simple, vapour, douche, and douche with massage, of varying temperatures and duration, but often prolonged on the supposition of securing more absorption of the

constituents. Many of the hotels have their own mineral baths. Catarrh, gastro-intestinal and bronchial (for which there are inhalation chambers), rheumatism, gout and their complications, such as stiff joints and exudations, also eruptions such as acne and psoriasis, liver disorders, hæmorrhoids and abdominal plethora, are often successfully treated at Aachen, but the special treatment there is for syphilis, and probably two-thirds of the patients go for this. Sometimes it is successful in cases when mercury has disagreed or failed to cure, sometimes it seems to aid the elimination of the drug previously deposited in the system, so that salivation even occurs. At other times definite manifestations of the disease, such as ulceration on tonsils, etc., recur with the disappearance of obscure pains, glandular enlargements, etc., so that the waters have been prescribed as a test for the latent malady, *e.g.*, when the question of marriage is proposed.

Mercury is also commonly used in the treatment of syphilis at Aix, not internally, but by inunction of mercurial ointment, from 1 to $1\frac{1}{2}$ dr. being used daily after a warm bath. The value of the baths and water in the treatment of this disorder lies in their (1) increasing the specific action of mercury; (2) preventing salivation and other injurious effects of the drug; keeping the skin in an active state, the glands secreting, and the pores free. As a rule the patients are directed to live well, eat freely of animal food, drink wine, and to be constantly in the open air; but in some cases milk diet is more suitable. Rheumatoid arthritis is also treated with some success at Aix, which has both a winter and summer season. As the treatment is highly stimulating, it is not suitable for apoplectic and hæmorrhagic cases; it is also exhausting and needs an after-cure.

Burtscheid is a suburb with weaker but hotter springs used mainly for rheumatism.

Weilbach, in the valley of the Main, on the eastern slope of the Taunus Range, 440 feet in altitude, has a good cold sulphurous spring for internal use, the quantity of sulphuretted hydrogen amounting to 0.16 cubic inch (5 parts per thousand). Carbonic acid is also present; the amount of salts is small, a few grains only of chlorides and carbonates of sodium, magnesium, and calcium. There is also a Natron-lithionquelle with 15 gr. of chloride and of carbonate of sodium, and a fractional dose ($\frac{1}{7}$ gr.) of lithium, also,

it is said, of barium and strontium salts. This spa is specially indicated in some cases of lung disease, catarrhal or tubercular, when hyperæmic enlargement of the liver exists, or congestion of the abdominal viscera with hæmorrhoidal tendency, and it will sometimes relieve when Carlsbad and other soda springs cannot be borne. Roth has given reasons for believing that sulphuretted hydrogen, taken in solution into the stomach, acts directly on the blood in the portal vein, forming a sulphuret with the iron of effete blood-corpuscles, and thus hastening their destruction, for the diminution of swelling in the liver under the influence of Weilbach waters is accompanied by a darker and, at length, black colouring of the fæces, in which a large amount of sulphuret of iron is found. This does not come from the water (which contains none of the metal), but either from the food or the blood, and in favour of its being from the latter is the fact that, as the liver decreases in size, an anæmic condition manifests itself in spite of plentiful nutrition. Roth, indeed, insists upon full meat diet during a course of these waters, and a chalybeate course is frequently required afterwards. Dr. Braun agrees with these statements, and himself derived much benefit from the waters when suffering from hæmoptysis connected with " hæmorrhoidal enlargement of the liver."

Generally they have rather a constipating effect, and do not increase the intestinal secretions like sulphate of sodium waters, though irritation and diarrhœa may be occasionally excited. The refreshing feeling and appetite caused by saline gaseous waters are not felt at the time of drinking these waters, but real *hunger* occurs in the course of the treatment. Besides their medicinal use in bronchial catarrh, they are valuable in chronic metallic poisoning. The muriated lithia spring is ordered for some gouty and urinary disorders.

Uriage is a large much-frequented thermal establishment, seven miles from Grenoble, in a beautiful Alpine valley 1,350 feet above the sea. The waters contain of sodium chloride 90 gr., of the sulphate and of calcium sulphate over 15 gr., half as much magnesium sulphate, a fractional dose (about $\frac{1}{24}$ gr.) arsenate of sodium, and 7 volumes of sulphuretted hydrogen in each quart. Temperature 81° F. They are used for drinking—1 to 2 glasses in divided doses as alterative, 4 to 6 glasses as purgative—also in

all forms of bath douche and massage douche (as at Aix-la-Chapelle) for gout, rheumatism and uterine disorders, especially at puberty and at the climacteric ; in vapour and spray for catarrh, pharyngitis, etc., and also especially for acne, eczema, eye and ear diseases, as well as in gargle and lotion ; they are said to be of much service even in tuberculosis, and in syphilis, much as at Aachen. There is also a chalybeate spring used for anæmia and debility. The climate is salubrious, sheltered from strong winds, with cool nights and mornings even in summer.

Ax-les-Thermes, near Tarascon, is another high sulphur spa (2,340 feet), with numerous springs from 66° to 163° F., the active agent in most of which is sodium sulphide (stimulating), whilst in some, known as "degenerated," this salt has become changed into hyposulphite and sulphate and presumed to be rather sedative. They are employed in chronic bronchitis, rheumatism, scrofulous and other skin affections, much as at Luchon.

The situation in the Ariège valley is picturesque, the climate changeable, cold at night ; accommodation is good.

Las Escaldas, in the Eastern Pyrenees, near the Spanish frontier, at a height of 4,400 feet, has similar waters at a temperature of 109° F.

Amélie-les-Bains, in the same department, lower down (920 feet), in a valley surrounded and sheltered by high mountains, has saline sulphurous water, 86° to 144° F., with much mucilaginous organic matter ; they are stimulating in their effects and used in respiratory disorders for which also the mild dry winter climate is suitable, in dyspepsia and liver complaints, as well as in those of the skin and the bones and in rheumatism.

Vernet-les-Bains, Le Vernet, same department, is about 2,000 feet above the sea, and is also a winter station frequented for the same maladies. There is a cold sulphur spring, but most of the waters are warm, 90° to 136° F., and contain sulphide of sodium with some sulphate, bicarbonate, etc.

Baden, a small town one hour south of Vienna, in the Helenenthal, 700 feet in altitude, is a favourite summer resort, and has many springs containing sulphuretted hydrogen and common salt, lime, etc., used mostly for baths (which can be taken in common), for chronic gout, rheumatism, skin diseases, etc. ; if taken internally for gastric or pulmonary catarrh they are diluted with whey

or other waters, since the natural temperature is from 95° to 120° F.; mud baths, local and general, are in use.

Baden, near Zürich, a quaint town on the Limmat, much shut in by woods and hills, has warm waters (118° F.) also used mostly for bathing. There is not the usual morning drinking at the springs. Sulphuretted hydrogen with sulphates and chlorides of calcium and sodium with a trace of arsenic are the principal ingredients, and brine from Rheinfelden is sometimes added, or Biemensdorf water for aperient effects.

Peripheral neuritis, stiff joints, sciatica, lumbago and muscular rheumatism, etc., are treated here, and "induration of the thymus gland" is specially mentioned. Most of the hotels have their own baths; massage is much used, and there are inhalation rooms for throat and chest disorders, also a "terrain-cur." The spa is 1,230 feet above the sea-level, and the town higher still.

Schinznach, also near Zürich, has a large and fashionable establishment close to the rapid Aar, at the foot of a wooded height crowned with the old Hapsburg Castle, whence it is known as the Hapsburger Bad. The grounds are extensive, apart from the village, and more than 1,000 feet above the sea, but so sheltered that the summer climate is rather hot and the air calm. The copious waters, 82° to 95° F., are strongly sulphurous, with 37 volumes of sulphuretted hydrogen and some calcium sulphate, sodic chloride and carbonic acid. They are taken internally and used externally in bath, which is often prolonged for one or two hours, in douches, mud, spray, inhalation, etc., for chronic catarrhal conditions and asthma, leucorrhœa, gout and rheumatism, and especially for skin diseases, eczema, acne, psoriasis, furunculosis, scrofula and caries. The cold muriated iodide water of Wildeg, three miles away, is ordered for internal use.

The **Hungarian "Hercules-Bad,"** near Mehadia on the Danube by the Roumanian frontier, is the most frequented in that part of Europe, and is said to have the largest volume of thermal waters of any known spring. They are mostly muriated sulphurous, one containing 42 volumes of sulphuretted hydrogen, though curiously the one which gives its name to the spa is free from it, being only a strong saline. The temperatures vary from 70° to 133° F. The cases treated include cutaneous, respiratory and hepatic disorders, syphilis and mercurial cachexia, in fact

much the same as at Aachen, with the waters of which place these are compared. Their location at the foot of the Carpathians is one of great natural beauty, though not elevated (570 feet); the season is from the 1st of May to October.

Helouan-les-Bains is an artificial oasis, sixteen miles south of Cairo, surrounded by desert, 200 feet above sea-level and 140 feet above the Nile, which is three miles distant. It has lately developed as a climatic winter station, and besides it has a remarkably dry and sunny air, an average of eight hours' daily sunshine during the winter months (Page May) and ten days' rain in the year; it has a valuable group of thermal waters, sulphurous, saline and chalybeate. The four or five sulphur springs at a temperature of 90° F. contain about 90 gr. of sodium chloride in the quart, 5 of potassium salt, 9 of magnesium and a few of calcium sulphate, more of the carbonate with a little iron and alumina, and a large amount, 4 cubic inches, of sulphuretted hydrogen (which is about the same as the Montpellier spring at Harrogate), also much carbonic acid. The gaseous saline alkaline at 77° F. contains chlorides and sulphates, the chalybeate contains salt and sulphates as well as iron. There is a splendid modern bathing establishment opened last year, and suitable cases are rheumatic and gouty, syphilitic and other skin diseases, neuroses, anæmia, chlorosis, etc.; as a climatic station, it is good for chest, renal and nervous disorders, etc., though some find it cold in winter.

Gurnigel is a cold sulphur spa not well known in England, but valuable on account of its pure and bracing air. It has a large and well-furnished establishment on the mountain of the same name, four hours by diligence from Berne, 3,700 feet above the sea in the midst of pine forests well laid out. These render the air somewhat moist, but there is ample sun. Of the two sulphur springs, the Schwarzbürnneli contains the large amount of 24 volumes of sulphuretted hydrogen in the quart with 400 of carbonic acid, nearly $\frac{1}{2}$ gr. sulphides of calcium and magnesium and 15 of sulphate of calcium with some carbonate and phosphate, traces of lithia, iron, common salt, etc. The Stockquelle has much less gas. There is a chalybeate near. Good results are obtained in gastric catarrh and cardialgia, intestinal catarrh, hæmorrhoids, biliary and pelvic congestions, bronchial catarrh and granular pharyngitis, general weakness and anæmia and also eczema.

Bad Boll is another cold saline sulphur spring in the Würtemberg Black Forest, at a height of 1,340 feet.

Neundorf, near Hanover, also well wooded, but not so high (230 feet), has a cold sulphur spring for drinking with still more (45 volumes) sulphuretted hydrogen, also a strong saline with sulphurous mud baths and inhalations for cases of catarrh, rheumatism, gout and skin diseases.

Langenbrücken, near Heidelberg, somewhat higher than the last named, has weak cold sulphated sulphur waters used for catarrh, hæmorrhoids, etc., and in bath for rheumatism.

Eilsen, between Hanover and Rehme, lies in a lower valley, with many springs containing calcium sulphate and a large quantity (49 volumes) of sulphuretted hydrogen in the quart. Gas inhalations and also mud baths are given.

Meinberg, between Cassel and Hanover, near Pyrmont, in a wooded district 660 feet high, has similar waters not so strong in sulphur gas, and also a cold salt spring with carbonic acid—which gas comes up also from the ground and is used in bath—it impregnates also earthy chalybeates near. The sulphurous mud-baths are in repute for rheumatism.

Enghien, a small town on a low level close to Paris, has a good establishment with cold sulphur-lime waters used in various hydropathic and inhalation methods for respiratory affections, rheumatism, tuberculous diseases, etc.

Challes, near Aix-les-Bains, at an altitude of 880 feet, has strong cold sulphur waters which are supplied also to that spa; they contain about 7 gr. of sodium sulphide to the quart with small quantities of iodide and bromide, and are used in chronic catarrh of the throat, pharynx and bronchi, ozæna, and tuberculous and syphilitic cachexia.

Stachelberg, in Canton Glarus, has waters of similar composition but not so strong; it is however much higher, over 2,000 feet, in a beautiful position and with well-appointed establishment: it is especially sought for chronic laryngitis and skin complaints.

Ternens, in the Landquart Valley, is 1,000 feet higher still, and has cold springs impregnated with sulphuretted hydrogen.

Heustrich, 2,000 feet above Thun, has cold springs containing small proportions of sulphide, sulphate and bicarbonate

of sodium, as well as a fair amount of sulphuretted hydrogen; used in chronic catarrh, etc.

Allevard (Isère), near Goncelin Station, is beautifully placed, about 1,500 feet above sea-level, and has a modern establishment with cold saline sulphur waters used for drinking and inhaling in chronic catarrh, and baths which are commonly prolonged for skin affections. Baths of whey are also used here as sedatives.

Harrogate, now perhaps the most fashionable and frequented of our spas, is situated on a breezy upland surrounded by the moors of Yorkshire, the "High" Town being 500 to 600 feet above the sea-level, the "Low" sloping down to half that altitude. The situation, "midway between the Irish Sea and the German Ocean," and the level open country, without forest, river, or sheets of water, contribute to a fresh bracing climate with less than average rainfall, whilst the modern splendid hotels, gardens, establishments and the Victoria Baths are all that could be desired.

The waters, remarkable for their number and variety, are grouped into: (1) Pure sulphur. (2) Saline sulphur: (a) strong, such as the Old Sulphur Well (Pump-room and Montpellier Sulphur Well); (b) mild sulphur (Pump-room), mild Montpellier, magnesia. (3) Iron waters, pure, saline, and with sulphates.

Dr. Oliver gives comparative tables of the foreign waters already described and points out the greater activity of those containing *sulphides* as compared with those containing only *sulphuretted hydrogen*. The Old Sulphur Spring, perhaps the most commonly used for drinking, is cold, and contains *both*; about 1 gr. of the former and 36 volumes of the latter in the quart, with upwards of 180 gr. of common salt, and other chlorides, including magnesium, calcium, and more than a grain of barium (to which importance is now attached as a heart tonic), also some carbonic acid. Most of the waters in group 2 are of this type, but the Strong Montpellier has nearly 3 gr. of sulphide without sulphurous gas; these and the Magnesia Spring are notably free from sulphates. Both classes of this group are alterative, stimulant and diuretic; the strong are also aperient, the "mild" more antacid, and these are often taken warm—from one to three tumblerfuls at intervals before breakfast; they are used also for bathing. Those in group 1, as at Starbeck, are alkaline with soda, not highly mineralised and used mainly in bath.

Of the chalybeates, the Kissingen, which is really more like a Homburg water, contains a grain or so of carbonate with 1 per cent. of chloride of sodium and 15 gr. of chloride of calcium, and the chloride of iron spring contains between 1 and 2 gr. of that salt and of the carbonate with common salt and other chlorides, including barium. The so-called "alum well" contains proto- and persulphate of iron, with sulphates of aluminium, calcium and magnesium.

The social resources of Harrogate and the pleasant climate of summer and autumn (June till October) attract many classes of invalids, but the most suitable cases for treatment by the waters are—dyspepsia with inactivity of liver and bowels; constipation, obesity, swellings of joints and glands, chronic skin diseases, gout and rheumatism, syphilis, etc.; cases of incipient phthisis and disordered menstruation in young women are also sent here with advantage, and use the warm sulphur baths whilst taking the chalybeate water internally.

Llandrindod Wells, situated on an open plain, high up (about 700 feet) amongst the Radnorshire hills, and sheltered on the east by Radnor forest, has much developed of late years. The climate is bracing but mild with less than average rainfall, so that the place has been called the Montpellier of Wales, whilst the presence of cold saline, sulphurous and chalybeate waters has led to the designation of a "mild Harrogate." The Old Saline, temperature 48° F., has upwards of 80 gr. chloride of sodium in the quart with 17 of calcium and $\frac{1}{2}$ to 1 gr. of magnesium chloride, a little sulphate and carbonate of calcium, iron, alumina, traces of lithium, thallium, etc., and of sulphuretted hydrogen as well as of nitrogen and carbonic acid. The New Saline is a little stronger, the Rock or Park a little weaker. They are more or less laxative according to dose—six to eight glasses are still ordered here—and are often taken hot in dyspepsia with constipation, liver congestions, gout and rheumatism (in which case sulphur may be combined), and chronic glycosuria.

The Old and the Park sulphuretted springs contain from 1 to 14 volumes of the gas, but little sulphide (of ammonia); 15 to 40 gr. of sodium,—1 to 10 gr. of calcium,—1 to 6 gr. of magnesium chloride, and the latter spring has also some magnesium sulphate and carbonate like the "mild sulphur" of Harrogate;

they are similarly used in chronic catarrh, gastro-intestinal and bronchial, in some renal and vesical and cutaneous disorders, as well as in gout and rheumatism. The magnesium spring contains an unusual amount (12 gr.) of the chloride of that metal in each quart, with nearly twice the amount of calcium and five times that of sodium chloride with a little sulphuretted hydrogen. It is said to be valuable in tuberculous disease, diabetes, etc. The chalybeate spring Rock Spout, with a good proportion of the same chloride, contains $\frac{1}{4}$ to $\frac{1}{2}$ gr. of carbonate of iron. It is suitable for anæmia with digestive torpor, but if wrongly used causes headache and palpitation.

Lake Vyrnwy Hotel, a few hours distant and some hundred feet higher, is said to be good for an after-cure.

Builth is a small picturesque town about seven miles away in the valley of the Wye with similar waters (Builth Wells).

Llangammarch, about thirteen miles south of Llandrindod, may be considered here because of its sulphur water, but is more commonly reckoned amongst the muriated waters because of its spring containing a moderate amount of the chlorides just mentioned, as well as the unusual amount ($1\frac{1}{3}$ gr.) of barium chloride. The place is prettily situated at a height of 600 feet in a wide valley amongst the Brecknock hills, and has a pure and bracing air; the waters are used for bathing and drinking in dyspepsia, rheumatism, chronic glandular disorder, and latterly in weak heart and chronic valvular disease (Lancet, ii., 1894). The barium salt is presumed to strengthen the contractions whilst reducing their frequency, and the Nauheim treatment is in use here. Dr. W. B. Jones has shown that they promote elimination of uric acid (*ibid.*, i., 1900).

Llanwrtyd Wells, a few miles farther south and 200 feet higher, is an older and larger spa, ranking next to Llandrindod. The waters have 35 volumes of sulphuretted hydrogen to the quart, and there is a mild chalybeate.

Strathpeffer, which also has developed of late years, lies in a beautiful open valley near the west coast of Ross-shire, sheltered by mountains towards the north and 200 feet above the sea, which is five miles away. The climate is mild and suitable for spring or winter as well as summer, when the place is apt to be crowded. The rainfall is below the average.

Of several sulphur springs, the Strong Well contains, besides the large somewhat varying amount of 40 volumes of sulphuretted hydrogen, $\frac{1}{3}$ gr. of potassium and $\frac{1}{10}$ gr. of sodium sulphide in the quart, with a good deal of calcium sulphate and carbonate, no chloride of sodium, but some sulphate and more magnesium sulphate. The waters are cold and without carbonic acid, are as a rule not aperient but the contrary, and especially when first commenced, not easily digested; they may agree better when warmed, but in any case cause hunger, and later on digestion improves, as in gastric catarrh; congested or "Indian" liver cases do well, douche baths and massage being also employed; abdominal plethora, "acidity," chronic gout, rheumatism and eczema are very suitable for these waters (F. Fox). In the fine modern bath-house they are used in all forms, as also in spray for inhalation, and good *peat* baths are available. There are many carbonated iron springs near, and the Saint's Well has about $\frac{1}{2}$ gr. to the quart, kept in solution by so much carbonic acid as to effervesce when drawn; this is stimulating and tonic for anæmia, etc.

Moffat, in the upper part of Annandale in Dumfries, is 400 feet above the sea, with a good climate and picturesque surroundings. The water, which is cold, contains $2\frac{1}{2}$ cubic inches sulphuretted hydrogen in the pint with 22 gr. of chloride and 2 gr. of sulphate of soda. It is used internally in much the same cases as the Harrogate sulphur water. There are also saline and ferruginous springs.

The principal sulphur wells in Ireland are at **Lisdoonvarna**, which is situated in a bare country, 430 feet above sea-level, about twenty miles from Ennis (Co. Clare). They are said to contain 5 volumes of sulphuretted hydrogen in the quart, and are much used, but the accommodation is (or was) insufficient. There are also chalybeate springs and sea baths. Dyspepsia, skin eruptions, chronic rheumatism and gout are treated here.

Lucan, in Kildare, not far from Dublin, and **Swanlibar** (Co. Cavan) have also good sulphur waters which were formerly much frequented.

CLASS 9.—EARTHY MINERAL WATERS.

Wildungen, one of the oldest North German spas, is well placed in an open valley, amidst wooded hills, nearly 1,000 feet above the sea, in Waldeck, within easy reach of Cassel. The spa portion of the town is mainly a street of villas and hotels,—Brunnen-Allée, at the end of which is the chief spring, the George Victor, though it is less strongly mineralised than the Helenenquelle (which is half a mile away) or the König; these waters are cold and contain from 5 to 15 gr. of bicarbonates of calcium and magnesium, some common salt and a little bicarbonate of iron well aerated with carbonic acid; the Helenenquelle is the more alkaline from sodium bicarbonate. Of these, the König has the most iron, but stronger is the Stahlquelle, about two miles away, also freely aerated, and near it is a weaker earthy chalybeate. With these resources and the bracing air, many forms of illness are treated here, but almost all have some renal or bladder symptoms, gravel or calculus, cystitis, stricture, pyelitis, results of gonorrhœa or enlarged prostate. The alkaline spring is chosen for irritable bladder with highly acid urine and it is better digested, but in cases of catarrh with alkaline or phosphatic secretion the George Victor or the stronger iron springs are good.

The special surgical skill of practitioners at Wildungen is also in high repute, and is often called upon in addition to the waters and the baths, which latter are used warm and made stimulating by carbonic acid and added salt, with the object of improving the contractile power of the bladder, etc. Gastric, intestinal and bronchial catarrh, anæmia and nerve disorders, especially when connected with gout, do well here, besides that the quiet and beautiful surroundings furnish an excellent air-cure.

Leuk (Leukerbad, Loèche-les-Bains), on the north bank of the Rhône, in the canton Wallis, at the foot of the Gemmi Pass, is 4,670 feet above the sea. The principal spring, the Lorenzquelle, contains 15 to 18 gr. of calcium sulphate in the quart, with some magnesia and traces of alkalies and iron. It is used internally in doses of one to five tumblerfuls taken at a high temperature (122° F.), and is rather constipating, but diuretic and diaphoretic. Braun attributes more importance to the *warm fluid* than to the ingredients.

The speciality of Leuk is the mode of bathing: there are four public pools, each three or four feet deep, and accommodating about forty bathers, who, clothed in flannel, amuse themselves with conversation, games, etc., and spend the greater part of the day in the warm mineral water. The time is gradually extended from half an hour to five and even eight hours in the day for about ten days, and then gradually diminished in the same proportion, so that a course is completed in about twenty-five days. The sexes are separated under the new regulations, and a very complete system of douches and of private baths has been added. The diseases thus treated include gouty and rheumatic exudations, visceral enlargements, scrofulous and other ulcerations, and chronic eruptions, such as psoriasis, eczema, and prurigo. In such cases the lime sulphate acts as a local stimulant, and often causes an erythematous or pustular eruption (*poussée*), which is the signal for diminishing the baths. The high situation of the Spa enables such stimulating treatment to be better borne than it would be elsewhere.

Weissenburg, in the canton Berne, near Thun, 2,758 feet above the sea, is situated in a narrow sheltered ravine surrounded by mountains and pine trees. The air is calm, mild, and moist, but the weather variable; the mode of life is simple. The waters are similar to those of Leuk, but with more magnesia, —rather less calcium sulphate, much less carbonic acid; temperature, 74·8° F. Excellent results in bronchial catarrh and some forms of phthisis are obtained at Weissenburg, but are to be explained rather by its general conditions than by the composition of the water (Braun). Pleuritic exudations are said to be rapidly absorbed. The waters purge in full doses (six to eight glasses), and sometimes cause dyspepsia at first. Baths are not used in phthisical cases (Rohden).

Lippspringe, a small town near Paderborn, on a partly sheltered plateau of chalk and sand, 441 ft. above the sea, has a lime spring containing about 7 gr. of sulphate and 2 gr. of carbonate of lime in the quart, with some sodium sulphate and magnesia, a little iron, some carbonic acid, oxygen, and nitrogen, the latter in comparatively large proportion (1·4 cubic inch); temperature, 70° F. Small doses (12 oz.) constipate, medium quantities regulate the digestion, whilst 30 to 36 oz. commonly relax the bowels.

It is remarkable that under treatment at this place the appetite and assimilative power of phthisical patients in an advanced stage have improved so much as to lead to an increase in weight of "10 lb. in four weeks, and 21 lb. in thirteen weeks." Whatever the explanation, it would seem that the diseased lung-tissue is gradually expectorated during the treatment, with slight fever and moderate suppuration, so that cavities heal up, and a cure may be completed at higher and drier health-resorts. Possibly the heat of the water and its slight amount of gas, taken fasting, facilitate expectoration and assist in the softening of cheesy deposit and loosening of catarrh (Rohden). Possibly, also, the moisture of the atmosphere assists by keeping in the water of the lungs and skin; the climate is very equable and cool; moist west winds prevail; the noons are cooler, and the mornings and evenings warmer than in other places of the same latitude. Inhalations of nitrogen are also used here.

Inselbad, near Paderborn, is commonly mentioned with Lippspringe as a resort for phthisical subjects, on account of the nitrogen in its medicinal waters. The gas is also inhaled. The weak salt spring (6 gr. chloride, with 2 gr. lime carbonate) is considered valuable in hæmoptysis (Hörling).

Contrexéville (Vosges), in the valley of the Vair, on a broad plateau more than 1,000 feet above the sea, open from north to south, has a bracing but changeable climate and cold alkaline earthy waters, now in great repute; modern bath establishments, covered promenades, casino, music, etc., have all been provided.

Of the four springs, the Pavillon is the best known and contains in the quart about 16 gr. of calcium sulphate, 6 of carbonate, a little soda, magnesia, lithia and iron carbonate, and traces of arsenic and fluoride of calcium with some carbonic acid. It is moderately alkaline with pleasant, slightly astringent taste; is limpid, but forms a pellicle on exposure. It is largely bottled and exported; for a cure at home, from half to one bottle daily for twenty-five to thirty days being taken with milk, wine or spirit (Cruise); it generally agrees better taken fasting than with meals, and has a diuretic, slightly laxative action (the latter especially if taken with meals or in the evening). Of the other springs, the Prince has more iron, the Quai more magnesia, the Souveraine is more weakly mineralised than the others; as contrasted with

Vichy, Vals, etc., they are presumed to be less weakening and are even claimed as tonic. They are especially ordered in diseases affecting the urinary organs, gravel and calculus, either uratic, phosphatic or oxaluric; also in gallstone and colic; in diabetes, albuminuria, vesical catarrh, prostatic enlargement, inflammation, and chronic urethritis. In some cases the pain from the stone is increased after the use of the waters, and this is attributed to erosion causing more irritation of the bladder surface and probably indicating operation; contrary to what might be expected, there is evidence of their value in the enuresis of children when dependent on want of contractile power of the bladder (Debout d'Estrée—Cruise), from $\frac{1}{2}$ to 1 litre being taken in twenty-four hours. (This therapeutic effect would seem better explained by lessening of the irritating qualities of the urine.) Cases of rheumatism and gout, especially of the atonic and irregular type, and of uterine congestion, etc., are also benefited.

The climate, altitude and waters of Vittel and of Martigny-les-Bains are similar to those of Contrexéville, from which the two spas are a few miles to the north and south respectively, and similar cases are sent there.

Good accounts of the former especially have been widely circulated, but the imported waters have not been so much utilised in England, partly because they do not keep so well.

Bagnères-de-Bigorre, 2,000 feet up in the Hautes-Pyrénées (France), in the beautiful valley of the Adour, has, like **Harrogate**, three groups of waters, (1) hot, saline, earthy, like those of Loèche: (2) cold sulphurous, and (3) chalybeate.

Of the first, the Source Salies, 123° F., has upwards of 20 gr. of calcic sulphate with some bicarbonate, about 6 gr. of magnesium sulphate with a little iron, and a trace of sodium arsenate; other springs of this group are similar, but with lower temperatures; they are used both for drinking and bathing in acid dyspepsia and rheumatism, in urinary and pelvic and functional nervous disorders; the baths are often prolonged.

The cold sulphur waters, which have about $\frac{1}{2}$ gr. of calcium sulphide to the quart, are brought from Labassère a few miles away, and are used like those of the Pyrenean spas in early tuberculosis and laryngeal and bronchial catarrh. The iron waters, which are not gaseous but contain a trace of arsenic, are given in

chlorosis and debility. The climate is mild, rather moist but fairly bracing, good in winter; the establishments are of a high class and the environs attractive. Salut is another establishment a mile away.

Saint-Amand, near Lille, about 100 feet above the sea-level and on the border of a forest, is an interesting spa in which sulphur-lime treatment is carried on, chiefly by prolonged mud baths made with the thermal water (which contains a little calcium sulphate and sulphuretted hydrogen) mixed with the neighbouring earth, which also contains the gas and some iron; the bath once filled is retained by the patient during the course, being heated as required to about 98° F. It is commonly used early in the morning and if occupied for some hours' time, conversation and amusements are entered into with adjacent bath tenants, curtains being let down for entering and leaving the bath in the public rotunda.

Rheumatoid arthritis, neuralgia, stiff joints, chronic skin eruptions and varicose eczema, etc., are relieved; the arrangements are very good. The waters are also used for drinking, but are so weakly mineralised as to be commonly classed among the "indifferent."

Cransac (Aveyron, France), which lies below a still active volcano, at a height of nearly 1,000 feet, has cold calcium sulphate waters containing also magnesium sulphate (about 30 gr. of each in the quart), with a small quantity of other sulphates, potash, alum, iron and manganese; they are moderately aperient and used for dyspepsia with constipation, congestion of the liver and spleen, etc. The natural warm sulphur vapour from clefts in the mountain side is utilised in baths for chronic rheumatism as in the Stufe di Nerone, near Naples.

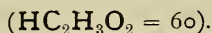
Pougues-les-Eaux, near Nevers, 700 feet above the sea, has a cold alkaline earthy spring, St-Léger (feebly mineralised with less than 20 gr. of calcium bicarbonate and less than 10 gr. of sodium in the quart), which is one of the table waters most used in France; it is also slightly gaseous, ferruginous and magnesian, and is taken for dyspepsia with tendency to diarrhœa, and for urinary disorders. Baths of all kinds, including carbonic acid, are also available and the surroundings are pleasant.

The **Bagni di Lucca**, at the foot of the Apennines, 500 to 1,000 feet above the sea-level, fifteen miles north of the town of the

same name, are amongst the oldest and best known in Italy. The three villages of the spa are beautifully placed and have a fine climate, so that they are sought by many visitors as well as patients; the latter are mostly the subjects of gout, rheumatism and their complications, including skin diseases. The springs, about ten in number, vary in temperature from 90° F. to 125° F. and contain about 20 gr. of calcium, and half that amount of sodium sulphate.

A grotto forms a natural vapour bath; the Aix-les-Bains massage, and mud and other forms of bath are used. June to September are the best months.

ACIDUM ACETICUM—ACETIC ACID



Acetic acid occurs in the Pharmacopœia in three grades of strength—(1) The glacial or concentrated acid, which is about three times as strong as (2) the ordinary acetic acid, which itself is eight times stronger than (3) the dilute acid. Vinegar is an impure form of the last mentioned.

ACIDUM ACETICUM GLACIALE—GLACIAL ACETIC ACID.

CHARACTERS AND TESTS.—At the mean temperature of the air, the acid is liquid, but at 34° F. it crystallises in colourless prismatic crystals, which are not unlike ice (whence the name glacial), and this form is retained up to a temperature of 60° F. The liquid acid has a pungent acetous odour, and is remarkable for the variations in its specific gravity according to its dilution. By the addition of 10 per cent. water, the sp. gr. is *raised* from 1·058 to 1·073, but any further addition of water permanently lowers it. The glacial acetic acid of the B.P. contains in 100 parts by weight, 99 parts of hydrogen acetate.

ACIDUM ACETICUM—ACETIC ACID.

CHARACTERS.—A colourless acid liquid of pungent odour and taste: sp. gr. 1·044. It is volatile, and, on evaporation, should leave no residue. It contains 28 per cent. of anhydrous acid.

ACIDUM ACETICUM DILUTUM—DILUTE ACETIC ACID.

One hundred parts by weight should contain 4·27 parts of hydrogen acetate, CH_3COOH .

ACETUM—VINEGAR. Not Official.

CHARACTERS AND TESTS.—Vinegar has a sp. gr. of 1·017 to 1·019, is usually brown in colour, and has a distinctive odour, due probably to a minute quantity of acetic ether: it contains 5·41 per cent. of acetic acid. It is liable to become mouldy if exposed long to the air, and in order to prevent this, a little sulphuric acid is commonly added: $\frac{1}{1000}$ part by weight is allowed by law.

ABSORPTION AND ELIMINATION.—The dilute acid is readily absorbed from the stomach, and combines in the blood, to some extent, if not wholly, with soda salts to form sodium acetate; like other salts of vegetable acids, this is ultimately eliminated in the urine as a carbonate.

PHYSIOLOGICAL ACTION.—*External.*—Glacial acetic acid is a caustic, and when applied to the ordinary skin causes redness, pain, and sometimes vesication or even inflammation of the cutis and subjacent tissue. The diluted acids exert a moderately irritant, or simply a cooling astringent effect, according to the degree of dilution, of continuance of application, friction, etc. Mucous membranes are severely irritated by the strong acid, much less so by the weaker.

PHYSIOLOGICAL ACTION.—*Internal.*—*Digestive System, etc.*—Dilute acetic acid in moderate doses has a cooling eupeptic action; it diminishes thirst partly by causing a flow of watery saliva. In large quantity it lessens the secretion of gastric juice, and so stops digestion and impairs nutrition. When taken continuously it is apt to cause gastric catarrh, dyspepsia, and consequent emaciation. Acetic acid is an important product of the fermentation of cellulose in the digestive tract of herbivora, and there is some evidence from the action of sodium acetate given to rabbits that it diminishes the activity of nutritive processes (Mallièrè, *Rev. des Sc. Méd.*, i., 1891).

The stronger acid, taken by the mouth, acts as an irritant poison, and has occasionally caused death; it induces burning sensations in the throat and stomach, and acute abdominal pain, with tympanitic distension, tightness across the chest, and much anguish; the buccal mucous membrane is whitened, the tongue becomes dry, cold, and tremulous, nausea and vomiting occur, with hurried, laboured breathing, and quick, small pulse; the

pupils are dilated ; cold clammy perspirations cover the body ; nervous tremor and sometimes convulsions have occurred.

SYNERGISTS.—Citric, tartaric, and other vegetable acids.

ANTAGONISTS.—**INCOMPATIBLES.**—As an antidote in poisoning by caustic alkalies and lime, vinegar is to be recommended, since it is generally near at hand, and the compounds formed by it are not injurious. It is useful also in alcoholic intoxication. Alkalies and their carbonates are chemically incompatible with acetic acid.

THERAPEUTICAL ACTION.—*External.*—The glacial acid is sometimes employed as a *vesicant* in Bright's disease, where the use of cantharides is unsafe. Besides this it is present in the acetum cantharidis as a solvent for the active principle of the Spanish fly, and increases its efficacy.

Nævi.—**Corns.**—**Warts.**—These have been treated successfully with the strong acid, and warts may be removed by a few applications of it.

Lupus, etc.—In the erythematous form, and also to certain pigmentary stains, the glacial acid may be applied about twice weekly, with much advantage and without production of scarring.

For **Frost-bite**, vinegar applied with friction is a good external application.

Parasitic Diseases.—Acetic acid (1 part in 3) has been applied in ringworm with good results, but other remedies are more commonly used. It is occasionally given as an enema (dilute) to destroy ascarides.

Psoriasis.—Acetic acid used locally promotes separation of the thick scales of psoriasis, and stimulates healthy action, just as a blister will sometimes do, but it causes much pain if the skin is fissured.

Pruritus.—A weak solution of acetic acid is sometimes useful in relieving itching of the skin.

Hæmorrhage.—Syringing with vinegar is frequently used as an astringent and styptic remedy for bleeding from the nose ; in metrorrhagia it may be used by vaginal injection, or tampons may be soaked in it : these, however, irritate and become unpleasant in four to six hours. It may also be used to check oozing from leech-bites, or to wash out the mouth after the extraction of a tooth. In

some cases the drinking of vinegar has led to arrest of the menses (Record, 1885).

Nocturnal Sweating.—The night-sweats which are so profuse and exhausting in the later stages of phthisis and in some conditions of debility, are often controlled by sponging the body with warm vinegar night and morning.

Spinal Weakness.—In cases of aching and debility referred to the lower spine, I have seen much advantage from sponging the back with equal parts of spirit of wine and dilute acetic acid.

THERAPEUTICAL ACTION.—*Internal.*—**Scarlet Fever.**—Dilute acetic acid is used by some practitioners from the commencement of this fever in all cases. Freely diluted, it certainly makes a grateful refrigerant drink; and sponging the body with hot vinegar and water twice or thrice daily is often useful.

Dr. J. Dougall specially recommends the aromatic glacial acetic acid impregnated with oil of neroli, rosemary, etc.—1 dr. to the oz. of water is used for sponging, and some is volatilised in the sick room (B. M. J., ii., 1879).

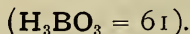
Diarrhœa.—When this occurs in the course of phthisis or hectic fever, it may sometimes be controlled by the internal administration of vinegar.

Syncope.—Inhalation of the vapour through the nose is sometimes employed, both to obviate syncope and remove drowsiness.

PREPARATIONS AND DOSE.—*Acidum aceticum glaciale*: 99 per cent. of hydrogen acetate, not given internally. *Acidum aceticum*: used externally as a rubefacient, vesicant, and escharotic. *Acidum aceticum dilutum*: dose, $\frac{1}{2}$ to 2 fl. dr., well diluted. *Oxymel*: dose, 1 to 2 fl. dr. *Acetum* (vinegar) (*not official*): dose, 1 to 8 fl. dr.

ADULTERATIONS.—Sulphuric acid and metallic impurities taken up from metal vessels in which it has been kept.

ACIDUM BORICUM—BORIC ACID



(Syn. Boracic Acid.)

It is found native, but is usually prepared from borax (sodium pyroborate), which also is found native as tincal, or may be prepared from boric acid or boracite (calcium-borate) by treating them with sodium carbonate.

CHARACTERS AND TESTS.—The acid occurs in pearly white lamellar crystals, or in irregular masses which are unctuous to the touch, but easily powdered; soluble in 25 parts of cold, 3 of boiling water, 4 of glycerin, 18 of rectified spirit, 30 of alcohol at 90 per cent.: still more soluble if with an equal part of borax. The taste is feebly sour and bitter, afterwards sweetish: it reacts like other acids to test paper, turmeric paper changing after brown to green on addition of potash: it gives a green tinge to flame.

ABSORPTION AND ELIMINATION.—Boric acid and borax are readily absorbed and have been found in the saliva, milk, sweat and urine within fifteen minutes of administration. Small doses are all eliminated in twenty-four hours—although when long continued or given in large quantities they may be detected several weeks after. The acid passes partly unchanged, partly as borate—the latter unchanged.

PHYSIOLOGICAL ACTION.—*External.*—Both substances are mildly antiseptic and anti-zymotic. The acid in $2\frac{1}{2}$ per cent. solution prevents the growth of bacilli, but even twice that strength does not destroy them: 7 per cent. prevents decomposition of organic solutions, broth, etc.

It is largely used for this purpose; 0.1 or 0.2 per cent. will preserve milk for several days, but often 0.3 is used (= 26 gr. to the pint); a 0.5 per cent. solution will keep meat fresh for eight days, 4 per cent. for three weeks—boroglyceride is often employed to avoid repetition. Weak preparations are moderately soothing, cleansing, antiseptic and astringent, but strong ones may irritate, especially if the surface is raw, and may cause some dermatitis, or discharge, or papular rash.

PHYSIOLOGICAL ACTION.—*Internal.*—Introduced originally as a sedative (*Sal sedativum Hornbergi*—1702), the acid was given as such—though with lessening confidence—down to the time of Binswanger of Munich (1846), who showed that it had no definite effect, and that borax acted like other soda salts: about thirty years later their present use as antiseptics was established and the question of the good or bad effect of frequently taking them in preserved foods has been much debated. Certainly both borax and acid in excessive amounts have caused poisonous symptoms, such as nausea, vomiting and diarrhœa, kidney and consequent bladder irritation with passage of albumin or blood,

some headache, pyrexia, depression amounting to collapse, also cutaneous eruptions, scaly or papular.

Doses up to 15 gr. given daily to children were not found to affect metabolism (Tunncliffe). Polli gave adults 30 to 60 gr. daily for three to six weeks without definite symptoms, and Liebreich gave large doses to animals without serious result (Pamphlet, London, 1899), but the symptoms above described have followed from the powdered acid introduced into the vagina or freely applied to wounds; also from a 5 per cent. solution continuously injected for an hour in empyema, or in psoas abscess, death following in a few days, probably because of deficient renal excretion (Rev. des Sc. Méd., 1890, and Vratsch, No. 31, 1881). The *post-mortem* examination gave negative results. A 4 per cent. solution used to wash out the bowel in diarrhœa has also caused toxic symptoms.

Chronic poisoning may be shown by more or less dyspepsia, or renal irritation or specially by a dry scaly condition of the skin, sometimes with bullæ or small hæmorrhages; the hair and nails may be affected; the mucous membranes become dry, the lips fissured and the gums inflamed with a dark line at their free border. Whether such symptoms can be traced to the amount taken in preserved foods must be held doubtful, Liebreich asserts the contrary and practically the delay of souring in town milk (by added boracic acid) is an advantage, if not abused.

It has been reported to impede assimilation and yet to increase the nitrogen and solids of the fæces (Med. Record, 1884), and whilst some children taking boric acid in milk got languid and drowsy (B. M. J., i., 1882), Tunncliffe and Rosenheim could not corroborate this for healthy children.

At a public health conference, general objections were taken to the process—especially as lessening evidence of decomposition, but no definite harm could be traced (Lancet, i., 1892; B. M. J., i., 1893).

THERAPEUTICAL ACTION.—*External.*—The chief local use of the acid is as a mild antiseptic. It is applied in the form of powder or lotion (1 part in 20 of water), as an ointment, or as boric lint, that is, lint steeped in hot saturated solution of the acid and then dried. The lint and lotion are usually coloured pink by the addition of a little tincture of cochineal or red litmus.

Ulcer, Granular Lids, etc.—The acid in solution is in frequent use as a wash for ulcers—it may be made with boric lint—or as a wet dressing for granulating surfaces, also in otorrhœa, stomatitis, leucorrhœa, or to wash out cavities. It has been much commended in granular lids when applied in conjunction with massage (*Lancet*, ii., 1890), but is not satisfactory (*ib.*, i., 1891). A lotion containing 2 to 6 gr. per ounce is, however, useful in catarrhal eye diseases. Boroglyceride is also used in ophthalmic practice (Fox) and as a surgical dressing, etc.

Skin Diseases.—Boric acid is used as a good addition to zinc and other lotions, and especially to starch poultices, when purulent secretions tend to decompose under the crust formed,—10 gr. in the oz. of water will often prevent this. The ointment is valuable in subacute eczema and dry irritable skin eruptions, and acts as a sedative for itching, but is a slight stimulant of healing. In acne, a lotion of $\frac{1}{2}$ oz. in 8 oz. of spirits of wine is often serviceable; it should be applied several times daily, the part being bathed at night with hot water and a little ammonia—no soap (*Dr. S. Port, Philad. Med. News*, i., 1890). The powdered acid is very useful in checking the fœtor of perspiration, and as a dusting powder, generally diluted. Borax is milder in action (*v. soda*).

Constipation.—The acid is said to act well in this complaint, when dependent on torpor of the colon with flatulence. If the rectal membrane is relaxed and prolapsed, the powder is applied or rubbed on to it; if not, about three-quarters of a teaspoonful is insufflated through a short wide tube: it is said to increase peristalsis, so much so as to cause several actions daily (*Pract.*, i., 1891).

Diphtheria.—Frequent local application of a strong solution or spray has given excellent results in this malady, and there is no contraindication to its simultaneous use with antitoxin.

Dr. Atkinson used 20 to 30 gr. with 1 dr. of glycerin and 7 dr. of compound infusion of roses (*B. M. J.*, i., 1882). The borate of magnesium (1 part of acid in 6) has some advantages (*ib.*, ii., 1887). Dr. Harries was well satisfied with boracic acid 2 dr., in $\frac{1}{2}$ oz. each of glycerin and water, applied every hour (*Lancet*, i., 1882), Dr. Goodhart with a saturated solution in glycerin. Almost any proportion can be incorporated under gentle heat. As a rule

the stronger applications are to be preferred as surer germicides, and their non-toxic and non-irritant nature is some advantage over mercury, iron, silver, and the stronger caustics.

Endometritis, etc.—Chronic endometritis has been successfully treated by Dr. A. Duke with intra-uterine applications of boric acid (B. M. J., ii., 1890); and suppositories of the same have been found useful antiseptics after parturition (*ib.*, ii., 1892).

THERAPEUTICAL ACTION.—*Internal.*—Given internally it is occasionally useful in cases of vomiting associated with fungi, in somewhat the same way as sulphurous acid is. It has been also given (with ether) in septic diseases, and has been recommended as a preventive in the same. In cholera epidemics, workmen in boric acid factories are said to escape (Med. Times, i., 1883).

Cystitis, etc.—Rosenthal has shown that about 10 gr. thrice daily of boracic acid suffice to deodorise and often to change the alkaline reaction of ammoniacal urine, with relief of symptoms of dysuria, etc. : in bad cases he conjoins washing out of the bladder with a 5 per cent. solution (Wien Med. Blät., 1881, and Pract., i., 1884). Dr. G. V. Percy has reported clinical illustrations of the efficacy of this treatment (Lancet, ii., 1884). Sir H. Thompson's formula is borax, 1 oz.; glycerin and water, of each 2 fl. oz.; for use, add $\frac{1}{2}$ oz. to 4 oz. of water. The borocitrate of magnesia is given as a urinary antiseptic in phosphatic deposits and before operations on the urinary tract, also in gout and rheumatism (Lancet, i., 1898).

PREPARATIONS AND DOSE.—*Acidum Boricum*, 5 to 15 gr. *Unguentum Acidi Borici*, 1 in 10. *Glycerinum Acidi Borici*. Lotions of boric acid and of boroglyceride are made with water, of the strength of 1 in 40 to 1 in 20—the latter must be prepared with hot water. A lint and cotton wool, a lozenge, pessary and suppository are also in use, and the acid is the principal ingredient in various private preparations, such as glacialine, antipyonine, branalcane, listerine and aseptin. *Boroglyceride* (Barff) is a borate of glycerin made by heating 92 parts of the latter with 62 of the acid, and is a more active antiseptic than the acid alone. The *Glycerinum* (B. P.) is very similar. *Borocitrate v. Magnesia*: dose, 15 to 30 gr. For borax v. soda.

ACIDUM CARBONICUM—CARBONIC ACID

($\text{CO}_2 = 44$). (*Not Official.*)

This gas occurs in the atmosphere in the proportion of 2 to 6 parts in 10,000 ; the air contained in the interstices of arable land has more, and in some grottoes and natural hollows, communicating probably with ancient volcanoes, carbonic acid accumulates, so as to exert toxic effect: this is the case in the well-known Grotto del Cane at Naples, the Upas Valley of Java, and in many parts of Auvergne and Vivarais (“estouffis”),—and it forms the “choke damp” of miners. The gas is contained also in all water in varying quantity, certain sparkling waters having a proportion of more than half their volume ; the Johannis water has more than 90 per cent. It occurs in all the liquids of the organism, principally in the blood, but also, in less quantity, in the urine ; in the former, it exists combined with alkalies, chiefly soda, and also in solution in a free state ; in the latter, Morin found a proportion of 20 cub. cent. to the litre : this was increased under administration of carbonated water, also after walking exercise ; but was greatly diminished by free drinking of ordinary water. It originates in the oxidation processes which are constantly taking place in the tissues, and it readily passes by osmosis through the animal membranes.

Owing to the evolution of carbonic acid in respiration and in the burning of fires, gas, etc., its percentage is always higher in dwelling-rooms than in the open air, although in London fogs it is said to be higher still. When the air of a room contains 0·1 per cent. of this gas, it is unfit for continued respiration, not only on account of the deleterious effects produced by carbon dioxide, but also because, together with this gas, volatile putrescible matters are given off from the mouth and skin, and these matters act in a prejudicial way upon the health ; hence the necessity there is for ventilation.

CHARACTERS.—A colourless inodorous gas of slightly sharp taste. It is soluble in its own volume of pure water at ordinary temperature and pressure—much more soluble under increased pressure and lowered temperature of the water. The solution gives an acid reaction, and is “sparkling” from the rapid escape of gas. Carbonic acid is much more soluble in water containing *phosphates* than it is in pure water, and, conversely, water contain-

ing the gas can dissolve and retain in solution *carbonates* and *phosphates* of magnesium, calcium, iron, etc., which pure water cannot. The sp. gr. of the gas is 1.526 (atmospheric air taken as 1). It is forty-four times heavier than hydrogen.

ABSORPTION AND ELIMINATION.—Carbonic acid is easily absorbed by denuded surfaces, and by mucous and serous membranes. That it may be absorbed also through the unbroken skin is apparent from the systemic effect produced not only by carbonic acid baths in general, but by keeping separate limbs in an atmosphere of the gas whilst the respiratory organs are protected from it (Collard de Martigny). If taken in solution into the stomach, it is said to be absorbed, if the viscus be *empty*,—whilst if it be *full*, the gas is rejected by eructation and *per anum* as *flatus* (Lehmann). Up to a certain amount, it may be absorbed through the lungs by the blood. In any normal condition, the blood is never *saturated* with the gas, but is always ready to receive more as it is freshly formed in the tissues. It circulates partly dissolved by the plasma and partly combined with alkaline salts. It is eliminated almost entirely by the lungs and the skin, but in small proportion by the kidneys; also by the bowel.

PHYSIOLOGICAL ACTION.—*External.*—When carbonic acid gas undiluted is brought into contact with the skin, it causes some prickling and sensation of warmth, with or without redness; this is said to be most marked about the perineum and scrotum—the latter contracts under its influence. To this effect succeeds a certain degree of anæsthesia (Rotureau) or analgesia, which, however, is not complete enough for operative purposes. In contact with mucous surfaces, or the exposed cutis vera, the effects are more marked, and more quickly produced. The oculo-nasal membrane is especially sensitive to a current of the gas, whilst the uterine membrane and even wounded surfaces show the anæsthetic effect without much previous stimulation.

Professor Kolbe of Leipzig has advocated the use of carbonic acid as a preservative of meat, having found that beef will remain perfectly fresh, and its taste unchanged after hanging for eight days in a chamber filled with the gas.

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—When taken into the stomach, as it usually is, in aqueous solution, carbonic acid is refreshing and thirst-quenching. It

somewhat increases the gastro-intestinal secretions, and excites their peristaltic action, but diminishes the sensibility of the mucous membrane; a moderate quantity improves appetite, but an overdose lessens it. No such serious symptoms follow, however, as after inhalation of the gas.

Respiratory System.—The gas is markedly more poisonous when inhaled than when taken in any other way. It hinders exhalation of the carbonic acid normally existing in the blood, and is itself absorbed in small quantity, thus inducing dyspnœa; a proportion of 10 per cent. in the air is irrespirable and fatal, but a much smaller amount (0·1 per cent.) causes unpleasant symptoms, such as headache, sleepiness, and depression. The undiluted gas first excites irritation and sometimes spasmodic contraction of the glottis with consequent asphyxia (Waring); in any case, and independently of such spasm, it soon arrests respiration. It has been thought that the gas is itself inert, and induces death only by preventing the due interchange of oxygen and carbonic acid in the lungs (Bichat, Regnault, etc.), but recent observations suggest that it is actively poisonous, since young mammals die by cardiac arrest, after two or three minutes in an atmosphere charged with it, whilst they live fifteen to twenty minutes in nitrogen or hydrogen (Paul Bert, Rabuteau), and the heart continues to beat in the latter case after respiration has ceased. Complete insensibility can be produced in animals before any danger to life arises; Paul Bert used the gas mixed with air or oxygen for the production of anæsthesia. Haldane and Lorrain Smith found that when they breathed air containing 18·6 per cent. of this gas, hyperpnœa, distress, flushing, cyanosis and mental confusion were produced within two minutes.

The symptoms of carbonic acid poisoning may be divided into three stages, which are those of asphyxia; the first is that of *dyspnœa*, the blood pressure rising; this is due to the excitation of the centres in the medulla oblongata (especially those of respiration and vaso-motor action) by the venous blood. Insensibility then comes on, and the second stage, that of *convulsions*, begins, the respiratory movements becoming more violent and spreading to all the muscles of the body; the third stage is that of *paralysis*, in which convulsions cease, the blood pressure falls, and the respirations, and finally the heart, stop.

Circulatory System.—The effect of respired carbonic acid in preventing oxygenation of the blood is quickly shown by the appearance of more or less cyanosis, with slow, laboured pulse, and ultimate arrest of the heart's action. Provided that a normal amount of oxygen is present carbonic acid does not combine with the hæmoglobin, since this remains red and unreduced in an atmosphere even highly charged with it, but in animals dying deprived of oxygen, the blood is found to be dark coloured, the hæmoglobin being completely reduced. The effects of the internal administration of the gas differ from those produced by its inhalation, and are such as slight stimulation of the heart-action, quickening of respiration, and increase of the peripheral circulation, with a slight prickling of the skin and a brief sense of exhilaration; this is often experienced from sparkling beer, wine, and even waters.

Neuro-Muscular System.—The most marked effects of carbonic acid poisoning (from breathing the gas) are exerted upon the nervous system. An amount of 3 per 1,000 in the atmosphere of a room will cause throbbing headache, with fulness and tightness across the temples, and giddiness; more of the gas may induce fainting, muscular weakness, somnolence, or insensibility, coma, or convulsions. On the organs of special sense, anæsthetic effects are preceded not only by prickling and warmth, but also by *muscæ volitantes*, tinnitus, and other phenomena connected with congestion. Herpin found that the gas, when diluted with 80 to 90 per cent. of air, produced gradual anæsthesia without suffocation or pain.

Nutrition.—Excretion.—The inhalation of carbonic acid modifies the processes of nutrition in a manner not yet understood; sugar has been found in the blood and liver of animals poisoned by it. More *diuresis* is caused by *carbonated* than by ordinary water, as carbonic acid increases the rapidity of absorption in the alimentary canal. It also increases the secretion of saliva, and so sparkling waters are useful in quenching thirst.

ANTAGONISTS.—Oxygen and stimulants of the peripheral circulation.

THERAPEUTICAL ACTION.—External.—Wounds, etc.—Demarquay and Leconte found that atonic and gangrenous ulcers and diphtheritic wounds recovered under applications of carbonic acid gas when they had not yielded to other remedies;

the stream of gas may be directed on to the wound, or a yeast poultice may be applied, and this evolves the gas. Good results in the same class of cases have been reported from Rehme, Nauheim, and other spas where the gas is employed therapeutically. Streams of carbonic acid have been applied to the eyes, ears, nose, vagina and rectum in inflammatory states of those parts. In all these cases the beneficial effect is probably due to the fact that the gas first causes a slight hyperæmia, and then by diminishing the sensibility of the peripheral nerves, lessens pain.

Vesical Catarrh, etc.—The pain, muco-purulent discharge, and irritability of bladder connected with this malady were formerly treated by local injections of carbonic acid gas. Sir James Simpson and others reported much improvement in severe and chronic cases (*B. M. J. and Med. Times*, 1858-59). The gas was disengaged from a carbonate mixed with tartaric acid, and conveyed through a catheter, the bladder being previously washed out if possible.

Gout.—Rheumatism.—Paralysis.—At Kissingen, Nauheim, and other places, baths containing carbonic acid gas are much used in these maladies, as a mild diaphoretic and stimulant to the skin, and in the Schott treatment of heart disease. Dr. Parkin wrote strongly upon the value of carbonic acid in gout, but administered it in the complex form of a strong alkaline effervescent draught (*Lancet*, 1843).

Pelvic and Uterine Pain.—In many painful affections of the pelvic viscera, whether neuralgic, or arising from organic disease, injection of carbonic acid into the vagina acts as an anæsthetic and sedative; but as it sometimes increases irritation for a time, it is not suited for cases with acute congestion. Dewees, De Ross (1834-35), and other physicians of still earlier date, used the gas with advantage, and Sir James Simpson records ample and favourable experience with it in dysmenorrhœa. It gives relief even to the pain of cancer, but seems to have sometimes caused giddiness, headache, and weakness (*Med. Times*, i., 1858). The warm chalybeate baths at Driburg (Westphalia), which are highly charged with carbonic acid, are said to be useful in cases of anæmic amenorrhœa and leucorrhœa, and to exert a favourable influence upon uterogestation, so that healthier children are born after their use. They have been described as “champagne baths,” and exert a stimu-

lating effect upon the whole surface, especially upon the genitals; they also induce a free secretion of urine.

At the *sool-sprudel* of Kissingen, especially when heated or when agitated by jet or wave, so large an amount of gas passes into the air as to cause sometimes giddiness and dyspnoea. At Rehme the baths are used "still" with better results. At this place, also, gas baths are given, but Dr. Braun does not attach much value to them unless in cases of atonic ulceration, and in irregular menstruation from atony of the uterus. Dr. Tyler Smith has pointed out that abortion occurs where pregnant women are exposed to the poisonous influence of the gas, but this may be secondary to the asphyxia produced.

Pharyngitis.—Laryngitis.—Chronic cases of this kind are treated at Ems by inhalation of the gas, and at Vichy by the carbonic acid douche.

Chronic Bronchitis.—Asthma.—Simpson states that he has often seen benefit from inhalations containing 5 to 10 per cent. of carbonic acid in these maladies, and in chronic cough. Such inhalations are much better tolerated than is commonly thought (Skinner), and they are practised at St. Moritz, at Ems, and elsewhere, but Dr. C. T. Williams speaks of danger arising from them, on account of difficulty in regulating the dose (*Lancet*, ii., 1873).

Vomiting.—Dyspepsia.—When the gastric mucous membrane is morbidly sensitive and irritable carbonic acid gas dissolved in water is an excellent sedative, and in uncomplicated cases is sufficient to relieve vomiting. It is commonly given in combination with an alkali, as in the ordinary effervescent mixture, or in the waters of Homburg, Carlsbad, Vichy, etc., but water charged with the gas *only* often answers exceedingly well, and has sometimes cured intense gastric irritation (chronic in character with great nervous depression) after the failure of treatment at celebrated spas. Champagne is thus often to be preferred as an alcoholic stimulant in cases of gastric irritability from the carbonic acid gas it contains.

Carbonic acid gas is sometimes used to distend the stomach and intestine for diagnostic purposes. Bicarbonate of sodium, 6 to 7 grammes, in solution is given, followed by tartaric acid, 5 to 6 gr., and this sets free the gas which distends the stomach if given by the mouth, or the intestine if given per rectum; the process is apt to be painful.

ACIDUM CHROMICUM—CHROMIC ACID— CHROMIC ANHYDRIDE ($\text{CrO}_3 = 100\cdot4$).

This substance is an anhydride, not a true acid. It is one of the oxides of chromium, and forms salts called chromates.

CHARACTERS AND TESTS.—The small crystals of chromic acid are either needle-shaped or columnar, dark crimson (ruby) at ordinary temperatures, black when heated, and incandescent at about 400°F. , when they fuse and become changed into sesquioxide (green) and oxygen. They are odourless and deliquescent, and the watery solution has a sour metallic taste, and much oxidising power: their relation to sulphuric acid is peculiar, being insoluble in acid of density 1·55, but freely dissolved by it when either more concentrated or more dilute. On contact, especially on warming, with glycerin, nitrous ether, strong alcohol, creosote, or any substance easily oxidised, explosive decomposition is liable to occur, although this may be prevented, it is said, by adding, *e.g.*, glycerin slowly, *drop by drop* (Phil. Med. Times, iv.).

The test, which is directed to the presence of sulphuric acid, is applied by dissolving 1 gr. of chromic acid in 100 c.c. of cold water, adding 10 c.c. of hydrochloric acid, and then 1 c.c. of test solution of chloride of barium, which should not cause more than slight turbidity (white).

PHYSIOLOGICAL ACTION.—*External.*—In full strength it is a powerful antiseptic caustic and disinfectant, coagulating albumin, abstracting water and forming an eschar, destroying organisms, decomposing ammonia and sulphuretted hydrogen, and oxidising organic matter. MM. Chevalier and Bécomt found that in certain factories where the bichromate of potassium was much used, the workmen suffered from severe ulceration of the septum nasi, glans penis and other parts, an effect which they considered to be due to the chromic acid in the salt just mentioned exercising its caustic action upon healthy tissues.

PHYSIOLOGICAL ACTION.—*Internal.*—It is not prescribed except as bichromate, but occasionally irritant poisoning has occurred from incautious application about the mouth, etc.: thus, in one case, some chromic acid, with just enough water to liquefy it, was applied to the tonsils of a woman on a cotton-wool brush, or pad, and although expectoration was encouraged, she swallowed saliva with a drop or two of acid, and half an hour afterwards had violent pain in the stomach, with “agonising vomiting” of green

fluid. Extreme collapse followed, and purging, but under stimulants she recovered in about three hours : there was then free action of the kidneys (Dr. W. Fowler, B. M. J., i., 1889). In another case, the acid had been applied to the gums, and similar symptoms began with severe pain in the nape of the neck ; and in another, death occurred from irritant poisoning and collapse twenty-seven hours after painting growths on the vulva with a strong solution (50 gr. in $\frac{1}{2}$ oz. of water) : the drug was detected by analysis in the viscera (*ib.*, ii., 1889). If after being taken internally, death did not occur from shock, it would probably do so from inflammation or destruction of the coats of the stomach.

Poisoning has also occurred from chromate of lead—chrome yellow, used to colour cakes, etc., but the symptoms caused are mainly due to the lead.

INCOMPATIBLES.—Oxidisable substances, as already mentioned.

ANTIDOTES.—Moderate doses of alkalies, and copious diluents and demulcents, such as milk and isinglass or gelatin, should be followed, if possible, by the use of the stomach tube,—stimulants and warmth being in the meanwhile applied.

THERAPEUTICAL ACTION. — *External.* — **Glossitis.** — **Ulceration of Tongue.**—**Syphilides.**—Mr. Butlin, after quoting Sir J. Paget on the value of chromic acid in gouty psoriasis of the tongue, gives some striking cases of improvement in the above conditions, from the frequent local application of an aqueous solution of the acid—10 gr. to the oz. (Pract., v., 30) : mercury or iodides were also given. These observations have been confirmed by Dr. Feibes with regard to specific ulceration of the tongue, nodules, mucous patches, and condylomata, but he used a stronger solution—1 part to 2—every second day, and obtained healing in eight days—a much better result than with nitrate of silver : after the application,—which is unpleasant,—he used mouth-washes of acidulated chloroform water, or of aluminium acetate (Pract., v., 48, 1892). He mentions no bad results, but the toxic cases already quoted should be borne in mind.

Goitre.—**Ranula.**—The next most important observation as to the value of this caustic was made by Dr. Woakes, who reported good illustrations of its value in the above disorders, when applied in saturated solution “on a carrier” to the inner wall of

the cysts, after evacuating or excising a portion (Lancet, i., 1890). The observations have been confirmed by Dr. Lowe and others (*ib.*, ii., 1890; ii., 1891), but the proceeding does not seem to be generally adopted, probably on account of the risks already referred to; special care, however, ought to guard against these.

Diphtheria.—Dr. Lesclure has maintained that the best agent for destroying the false membrane is a 40 per cent. aqueous solution of chromic acid, which is caustic, but is the weakest that is serviceable. Two or three drops are to be applied on wadding lightly to the false membrane only, and followed by thorough application of a solution of coal tar (1 in 20). For slight cases one or two applications are sufficient; in addition, glycerin of tannin is freely used daily (Bull. de Thérap., 1892).

Epithelioma (Rodent Ulcer).—I have reason to speak well of the method of use recommended by Dr. Allan Jamieson, *viz.*: thorough application and boring into the sore with a bead of the acid fused on a probe in a spirit lamp, after scraping and applying cocaine. The slough is allowed to separate, and the place to heal under zinc-ichthyol plaster; sometimes the application has to be repeated, because epithelioma is irregular in its growth, but the improvement is generally more permanent than with other remedies. This acid is also sometimes suitable for lupus; its freedom from sulphuric acid is important, so that the effect may be less diffused.

Sweating Feet.—A 5 to 10 per cent. solution has been used with great success in the Prussian army. One application is sometimes sufficient, but usually several at intervals of eight to fourteen days are required to effect a cure (B. M. J., ii., 1889).

Phagedenic Ulcers.—Poisonous Wounds.—It is used much stronger in these affections, as a powerful caustic and germicide. A 1 per cent. solution has been used as a hypodermic injection in cases of snake-bite.

Ozæna, Leucorrhœa, Gonorrhœa.—The weak lotion is similarly employed in these affections, to lessen and disinfect fetid discharges.

The local application of a solution of $\frac{3}{i}$ to $\frac{3}{i}$ of water has proved useful in chronic endocervicitis, applied once a week for four or five weeks.

Dyspepsia, Gastric Ulcer.—The bichromate of potassium

has been recommended in cases of dyspepsia associated with congestion of the stomach and in gastric ulcer; many cases illustrating its good effects have been published by Sir Thomas Fraser, and I have also used it largely with advantage, but its value is not generally known. It is given in doses of $\frac{1}{10}$ to $\frac{1}{5}$ gr. in the form of pill or tablet or aqueous solution.

PREPARATION.—Liquor acidi chromici, 1 in 3 of water. Catgut ligatures are often disinfected in a 1 per cent. solution (with certain precautions), and afterwards in sulphurous acid.

A "battery solution" is prepared with bichromate of potassium (powdered), 6 oz.; commercial sulphuric acid, 6 oz.; cold water, 48 oz. Mix carefully.

ACIDUM HYDROBROMICUM DILUTUM— DILUTE HYDROBROMIC ACID.

This is an aqueous solution containing 10 per cent. of gaseous hydrobromic acid ($\text{HBr} = 81$).

CHARACTERS AND TESTS.—The strong acid is gaseous at ordinary temperatures, colourless, non-inflammable, and irritating to the lungs: it is very soluble in water, but a concentrated solution gives off fumes, and must be kept in glass-stoppered bottles. Diluted with 90 per cent. of water, it is a colourless inodorous liquid with a strong acid reaction (sp. gr. 1.077 at 60° F.). Chlorine water when added liberates bromine, which colours the liquid yellow; with silver nitrate it gives a white curdy precipitate insoluble in nitric acid, and sparingly soluble in ammonia. It gives no precipitate with chloride of barium. The solution should not become discoloured by keeping.

PHYSIOLOGICAL ACTION.—Reichert has investigated the physiological action of the drug on frogs and other animals; it closely resembles that of other bromides (Pract., i., 1882).

Circulatory System.—Small doses cause a slight rise of pressure, due to the constriction of small bloodvessels; large doses diminish the blood-pressure even to zero, on account of the depressing action of the drug on the heart. Small doses produce no effect on the pulse; moderate doses cause a slight slowing, lasting a short time; with large doses the pulse may be slowed or quickened, but the tension is always low.

Nervous System.—The effect on the cerebrum is slight, consciousness being present until near death. The effect on

the spinal cord is to diminish reflex action, this being in the first instance due to its depressant effect on the sensory portions of the cord; later the sensory nerves and then the motor apparatus, including the muscular system, are also depressed (Boston Journ., i., 1881).

THERAPEUTICAL ACTION.—*Internal.*—This may be stated to be the same as that of bromides, but marked by less depression. Massini considers that it has a more pleasant taste, and is borne better by weak and sensitive stomachs; he administered the drug in thirty-one cases; in four of them there was no relief, in seven others very little, but in the remaining twenty the success was very great (Record, 1882). The cases in which it will be found most useful are those of insomnia, nervous palpitation of the heart, toothache, especially in pregnant women, and tinnitus, vertigo and mental depression.

Dr. Dana spoke highly of the drug in cases like those mentioned above, but in epilepsy found that the other bromides were more useful (Pract., 1883). Dr. Squibb recommended that the acid should be used intermittently with the bromides, and thus the patient kept under their influence without great depression. He also found it useful in preparing extemporaneous solutions of other bromides, for instance that of lithium, by prescribing it with carbonate of lithium (Record, 1884). It has also been recommended in palpitation and nervousness due to excessive tea drinking; but whether it is superior to the bromides is very doubtful. Dr. H. C. Wood, on the other hand, found it very useful in epilepsy when given in larger doses than usual, *viz.*, from $\frac{1}{2}$ oz. to 3 oz. daily. It has also proved serviceable in severe cases of chorea when other remedies, including arsenic and bromide of potassium, had failed to relieve (B. M. J., i., 1885). Most observers agree in stating that it does not produce bromism so readily as the bromides. It has been given with quinine to prevent cinchonism (but cannot be depended on for that purpose), and to remove the nausea following the use of morphine.

DOSE AND ADMINISTRATION.—On account of its great acidity the drug should always be given much diluted, and with sweetened water, or syrup of lemons. The dose of the acidum hydrobromicum dilutum (B.P.) is 15 to 60 min.; but Dana gives

from 1 dr. up to $2\frac{1}{2}$ dr. and Dr. H. C. Wood up to $\frac{1}{2}$ oz. These large doses seem reasonable since 1 dr. of the dilute acid is only equivalent to 9 gr. of the potash salt. Massini uses a stronger solution (25 per cent.), of which he gives 10 min. a quarter of an hour after meals.

ACIDUM HYDROCHLORICUM—HYDROCHLORIC ACID ($\text{HCl} = 36.5$).

Free hydrochloric acid is found in the gastric juice of vertebrate animals; in the mineral kingdom it occurs combined with metals, earths, and alkalies (sodium chloride, etc.), and in the springs of volcanic regions. The hydrochloric or muriatic acid of the *Pharmacopœia* is a solution of hydrochloric acid gas in water, to the extent of nearly 32 per cent. by weight.

CHARACTERS AND TESTS.—The pure acid is colourless, but the commercial acid “spirits of salt” yellowish, owing to the presence of some organic matter, as cork, or of ferric chloride from the iron stills in which it is prepared. It has a very sour taste and a suffocating odour, giving off white fumes when exposed to the air, from escape of the acid gas and its union with the ammonia of the atmosphere. A rod dipped in liquor ammoniæ and held over a bottle of the acid forms dense white fumes of sal ammoniac; nitrate of silver produces a curdy white precipitate of chloride of silver, insoluble in nitric acid, soluble in ammonia, and becoming dark on exposure to light.

ABSORPTION AND ELIMINATION.—The mineral acids in moderately strong solution may be absorbed through the skin. Dilute hydrochloric acid, taken internally, is absorbed by the stomach, probably unchanged, but any that passes into the intestines would have time to combine in part with soda, and form chloride of sodium before entering the capillaries. It has been said that any acid introduced as such into the blood becomes so closely combined with albumin as to reach the emunctories before being wholly saturated with alkali, but if so, the acid is not traceable by test paper (F. Walter, *Wirkung der Säuren*, *Archiv f. exper. Pathol.*, 1877). According to this careful observer, an acid reaction of the blood is incompatible with life. Elimination is effected mainly by the urine, the quantity and the acidity of this excretion being usually slightly increased.

PHYSIOLOGICAL ACTION.—*External.*—Strong hydrochloric, like other mineral acids, acts with energy on animal tissues, abstracting water, and combining with potash, soda and lime bases: it does not penetrate so deeply as sulphuric or nitric acid, but produces a white stain, and this part afterwards sloughs. In the digestive tract, large doses have a similar action, and excite gastro-enteritis.

Hydrochloric acid, in the strength in which it occurs in the stomach, about 0·2 per cent., is a fairly powerful antiseptic. A much higher dilution than this can check lactic acid fermentation.

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—Administered in moderate dose and dilute solution, hydrochloric acid has two main effects—(1) it augments the acidity of the gastric juice, and (2) after absorption, it gives rise to the formation of chloride of sodium. It is eupeptic, and also aids the solution of useful substances which would be otherwise inert, such as phosphate and carbonate of calcium, metallic iron, oxides, etc. The augmented acidity of the gastric juice, as a rule and within certain limits, improves the digestive power, increases the formation of peptones and also, it is said, peristaltic action; it is accompanied by greater secretion of saliva, and a sense of warmth at the stomach, but if carried to excess causes irritation.

A great part of the interest connected with the study of this acid depends upon the question whether it really forms an integral part of the normal secretion of the gastric glands, a question which has now been answered in the affirmative. Besides the older observations of Prout (Phil. Trans., 1824), Lassaigne, and others, we have the analyses of Schmidt (Die Verdauungssäfte, 1852) and of Gautier (Chimie Appliquée, 1874), who calculated the proportion of free hydrochloric acid as 3·05 per 1,000. Lactic, acetic and butyric acids may also be found in the gastric juice, as described by Cl. Bernard, Lehmann, and other authorities, but they result from chemical changes during the digestion of food. Enderlin, examining the quite fresh gastric secretion of an executed criminal, could find no trace of lactic acid, nor could any *organic* acid act on fluoride of calcium as gastric juice does (Melsens). Further, Rabuteau demonstrated by an original process the existence of hydrochloric acid in the secretion of fishes

(Comptes Rendus, 1873) and of dogs (Eléments de Thérap.). E. Küzl found that after the administration to dogs of iodide or bromide of sodium or potassium, small quantities of free hydriodic and hydrobromic acids respectively occurred in the gastric juice, as well as the usual amount of hydrochloric acid (Zeits. für Biologie, Bd. xxiii., 1887). The formation of hydrochloric acid ceases if no chlorides are given with the food (Voit); it is probably secreted by the so-called oxyntic glands of the stomach. The amount of free acid found in human gastric juice in cases of fistula is much less than that in the dog's gastric juice; but as pepsin and the other constituents are also small in amount, it is probable that the juice obtained in this way from invalids is poorer in its various constituents than is the secretion of the healthy. It is scarcely necessary to state that if administered undiluted, this acid causes irritant poisoning with symptoms similar to those described fully under sulphuric acid.

Circulatory System.—As the blood and lymph, and almost all the secretions of the body have an alkaline reaction, it becomes interesting and important to inquire what effect is produced upon such alkalinity by the administration of acids. Some observers, as Eylandt, Wilde, and Gaetgens, have concluded that any altered relation of acids and bases within the body occurs, if at all, within very narrow limits.¹ Hofmann held that an excess of free acid can pass through the blood to the urine, but this is probably incorrect. Miguel, after giving sulphuric acid, found the *alkaline*, especially *ammoniacal salts*, of the urine increased in amount—implying that the acid combined with alkali in the blood, and thus removed from that fluid for excretion an unusual proportion of such alkali. Salkowski arrived at a similar conclusion, and Lassar asserted, from analyses of blood, that its alkalinity was much lowered under the use of acids. But the estimation of urinary ingredients does not give a satisfactory answer to the question, and alkalimetry, as applied to the blood, is exceedingly difficult, hence another and an ingenious method of analysis has been adopted by F. Walter (*op. cit.*). Starting from the highly probable supposition that the carbonic acid contained in the blood must be almost wholly in combination with alkalis, and that its

¹ Souligoux attaches much importance to it, as altering galvanic reactions within the system.

amount must therefore be proportional to, and be an index of, the amount of alkali contained in that liquid, he analysed the gas-contents of blood withdrawn from animals under acid-treatment, as compared with that of animals in a normal condition. Most of his experiments were made with hydrochloric acid, because it required less water for dilution than other acids. From 1 to 3 grammes of acid were given diluted, in three doses, by the stomach tube, in the course of twenty to forty hours. The blood was drawn from veins after decided symptoms of acid-poisoning had set in, and when compared with normal blood it showed a remarkable *lessening* of the carbonic acid, and (by inference) of combined alkalies; this was especially the case in rabbits (herbivora). In dogs (carnivora) the difference was not so great, but a diminution of about 10 per cent. in the amount of CO_2 occurred under the influence of hydrochloric acid. This curious difference between the effects of the acid on the two classes of animals was first pointed out by Salkowski, and it was found that dogs have a certain immunity as to the general symptoms of acid-poisoning, so that they can take much larger doses than the herbivora without ill results. (This has been accounted for by increased formation of ammonia compounds in the former class of animals under the influence of the acid, causing its neutralisation to some extent.)

With regard to the influence of hydrochloric acid on the general circulation, it was noticed by early observers—Boerhaave and others—that even moderate doses accelerate the pulse and cause flushing of the face; and full doses produce some excitement of the cerebral functions so that the symptoms have been compared to those caused by alcohol (Deutsch). It causes first a rise, but in toxic doses a fall in the blood pressure (Walter). Bobrick took 18 min. diluted with 5 oz. of water, and within half an hour noted an increase of pulse by six beats; this continued for an hour, but was succeeded by a fall of four beats below the normal frequency. He noticed excitement of similar character after internal and external applications of the acid to frogs, and concluded that it was produced through the nervous system, for it did not appear after destruction of the nerve centres.

Respiratory System.—Toxic Action.—The fumes of hydrochloric acid are extremely irritant to the larynx and may lead,

even in very small amount, to fatal asphyxia. F. Walter found that in different animals of the same species the action of the acid was different; from 7 to 8 grammes of hydrochloric acid per kilogramme of body-weight might be given to a rabbit in one day without necessarily serious result, but if the proportion of 9 grammes in the same period were exceeded, death certainly followed within a few hours. The first symptom of poisoning was an increase of frequency in respiration; then the separate inspirations became deeper and more laborious, with violent heaving of the thorax; the heart beat so quickly that the pulse could not be counted; the animal lost power of moving, and lay quiet on the side for a quarter of an hour before death. The respiration then lost its dyspnoëic character, and grew superficial and weaker as collapse set in, and the heart ceased a few moments after the breathing. *Post-mortem* inspection revealed no sufficient change in the organism to account for these symptoms; hence, apparently, neutralisation of alkali, or withdrawal of some portion of alkali from the blood and tissues, was the cause of death; and this hypothesis was remarkably confirmed by the results of injection of an alkali into the blood-current. A rabbit that had received more than 6 grammes of hydrochloric acid in three days—three times as much as would kill it—together with 0.2 gramme carbonate of soda injected under the skin with each dose, recovered without any symptom of poisoning. Another animal received more than 2 grammes of acid, and just when the symptoms indicated the near approach of death 0.5 gramme of soda carbonate was injected into the jugular vein; within ten minutes the strong thoracic movements subsided, the heart's action became slower and stronger, the animal sat up and began to eat, and in an hour's time seemed quite restored. This direct antidotal action of injected alkali is very striking.

It would seem that the result of diminished alkali in the blood, besides a lessening of general metabolism, is first a stimulation and then a palsy of the respiratory centre, through which death may be induced. The dyspnoea is not connected with altered heart-action, and the paralysis of respiration must be distinguished from that of asphyxia, for the oxygen contained in the blood remains unchanged.

Urinary System.—Besides the observations showing that acids increase the ammoniacal salts in the urine, it should be stated that the urea is diminished, and that their administration in sufficient dose can certainly increase the acidity of the secretion; during digestion, however, the urine is less acid, and may even become alkaline. This is accounted for by supposing that the base, set free by the formation of hydrochloric acid in the stomach, is excreted by the urine, rendering it at the same time less acid (Maly); there is no such effect on the alkalinity of the saliva (Külz, *Zeits. für Biol.*, 1887); it may also be attributed to the alkaline phosphates present in vegetable food.

SYNERGISTS.—As refrigerant tonic and astringent, the other acids; as tonic and digestive, bitters, and also pepsin.

INCOMPATIBLES.—Alkalies and bases, salts of silver especially. To neutralise irritant poisonous doses of acid, the alkali should be given in mucilaginous or albuminous liquids.

THERAPEUTICAL ACTION.—*External.*—**Stomatitis, etc.**
—In inflammation, with patches of ulceration about the mucous membrane of the mouth and gums, hydrochloric acid, diluted with an equal part of glycerin and applied to the sloughing spots, will induce healthy action. In mercurial stomatitis, and in the aphthous conditions that occur in children or during advanced disease, lotions containing 1 part of acid in 10 of rose water, either alone or with chlorate of potash and glycerin, are very serviceable. The acid is also valuable given *internally* in such cases. To avoid possible injury to the teeth, plain or alkalisied water should be used immediately afterwards, or the solution may be sucked through a glass tube, quill, or straw.

In all forms of ulcerative sore throat, whether scarlatinal or otherwise, but especially when sloughing is present, and when there is marked general asthenia, hydrochloric acid is indicated as well locally as internally. It may be applied with a brush (1 part in 15 of liquid), or in gargle (2 dr. to 10 oz.). In gangrenous or “putrid” sore throat, the nearly pure acid may be lightly pencilled over the affected part.

THERAPEUTICAL ACTION.—*Internal.*—**Dyspepsia.**—There are two varieties of indigestion in which hydrochloric acid is especially indicated—the so-called “atonic” form, and the “acid” form—but the mode of its use is somewhat different for

each. Atonic dyspepsia occurs either in connection with general weakness or impaired hygienic conditions—for instance, in over-worked factory girls, seamstresses, etc.—or in well-fed persons who tax their stomachs with too much nitrogenous food whilst leading a sedentary life. The secretion of gastric juice is but scanty, and the patient suffers from weight and heaviness after food, from general oppression, and other signs of unfinished digestion. One indication for the treatment of such a condition is to supply additional acid to the gastric secretion: but, as we have reason to believe that adding such acid *before* a meal will check the formation of the naturally acid though scanty gastric juice, it is better to allow this to do what it can, and to prescribe our medicinal acid shortly *after* food has been taken, with the object of assisting nature, and not interfering unduly.¹ It is sometimes given after meals in small doses at short intervals.

In cases of “acid” dyspepsia, the patient suffers rather from heartburn and regurgitation of sour fluid, connected either with hyper-secretion from the gastric glands, or abnormal fermentation of starchy, saccharine, or fatty food. It is true that the symptoms may often be relieved by sodium bicarbonate, but in many cases more permanent relief will be given by dilute hydrochloric acid administered about half an hour before a meal. This will lessen the amount of the natural secretion and will check fermentation. It is only recently that this important distinction as to the *time* of taking an acid with reference to food has been recognised. Many writers, Nothnagel for instance, are satisfied with recommending its use always before meals, and certainly if it be given after food in cases of *pyrosis* or *water-brash* it will aggravate the mischief; these are the true cases in which its use is indicated *before* meals, when it exerts an astringent and antacid action. It is contra-indicated in acute inflammatory, and also in organic disease; and in any case its use should not be continued for more than ten to fourteen days at a time, or the digestive property of the gastric juice will be impaired, or catarrh excited.

Headache, especially felt in the temple and the brow with

¹ Manasséin showed that in dogs made anæmic by blood-letting, the normal proportion of acid and pepsin was altered, and in such animals an addition of artificial acid to the gastric juice was, *ceteris paribus*, more effective than in the healthy (Virchow's Archiv, lv.).

marked giddiness, is often connected with the dyspepsia above described, and is relieved by hydrochloric acid.

Chlorosis.—Zander praises hydrochloric acid in the treatment of chlorosis, and finds that it acts even more satisfactorily than iron (Virchow's Archiv, lxxxiv., 1881), but later observations do not confirm this (Hale White, Guy's Hosp. Rep., 1891; Stockman, B. M. J., i., 1893). Dr. Smart reported a case of advanced chlorosis, with atonic dyspepsia and absence of free hydrochloric acid in the gastric contents, much improved under 100 min. daily of the acid (in divided doses): he concluded, however, that the improvement was from favouring the digestion of proteids, not in restoring hæmoglobin, so that some form of iron was necessary for recovery (Lancet, i., 1893).

Diarrhœa.—In this complaint, hydrochloric is often preferred to other acids, not because it has a more energetic effect than sulphuric acid, but because it is better borne by the stomach. It is most reliable in cases that are due to abnormal fermentation in the bowels, with formation of lactic acid, as in what is called summer diarrhœa and gastric catarrh of infants; there are, however, many other remedies for this condition which are better than the acid.

Vomiting.—Small doses diluted have been found useful in many kinds of vomiting, *e.g.*, that of pregnancy, that of ordinary dyspepsia, of fevers, and even of cholera (Lancet, 1892).

Fevers.—In enteric fever, hydrochloric acid had at one time a high reputation; it was said to moderate the pyrexia, and to directly influence the morbid process. We scarcely expect so much now, but still there is reason to think that a judicious use of this acid may favour the assimilation of food, if it does not exert antiseptic influence. According to the investigations of Manassëin, in the gastric juice of fever patients it is not *pepsin* that is deficient but *acid*, and this deficiency may be supplied for a time by the artificial acid. It matters little whether we say with this observer, and with Chambers, that we supply deficient acid, or with Richardson, that we neutralise by it excess of alkali formed during fever. Chambers records an emphatic opinion as to its value, after a fairly extensive use of it at St. Mary's Hospital, in "low" fever, apparently typhus and typhoid. The treatment by hydrochloric acid was more successful than by any other method, but we must add that

he also paid strict attention to *nourishment*, giving milk and beef-tea regularly every two hours, day and night (Med. Times, 1858; Med.-Chir. Rev., ii., 1863). Henderson has reported on its value during an epidemic at Shanghai (Med. Times, i., 1863). On the other hand, Sir George Johnson was satisfied with the far better progress made by his typhoid patients in King's College Hospital when he *omitted* mineral acid from their treatment; especially, that diarrhœa was less troublesome, acids seeming to irritate the bowels, just as bread or meat would do (B. M. J., i., 1875). I believe the acid is sometimes useful, and if well diluted the doses required will not irritate the bowels; it may be given as a refrigerant drink in lemonade, or mixed with essence of meat so as to aid assimilation (*v.* Chlorine).

Scarlet Fever.—There is also evidence as to the value of hydrochloric acid in scarlatina. Osborne records a prolonged experience in its favour (Lancet, ii., 1862), and Egbert (Pennsylvania) has quoted nearly three hundred cases, all treated by a mixture containing this acid with chlorate of potassium (Ranking, i., 1873). He gave about 8 min. of acid with 20 gr. of chlorate of potassium every two hours to a child of six, and more or less according to age. Occasionally tinct. camph. co. was added to relieve restlessness; no applications were made to the throat, unless sometimes ice externally; only one death occurred. I constantly use hydrochloric acid internally and locally in cases of scarlet fever, where there is marked general asthenia with dark ill-developed rash, and tendency to sloughing in the fauces (*v.* Chlorate of Potassium).

Mental Depression, Melancholia.—Hydrochloric acid is sometimes useful in these conditions, but it is probably of less value than the nitro-hydrochloric acid.

Urinary Deposits.—In oxaluria, Dr. Prout long ago recommended hydrochloric acid, and its use is especially indicated for the impaired digestive power, and the anxious and depressed mental condition usually connected with the malady. It may be given *before* meals with a bitter, such as *nux vomica* or *chirata*, and continued till urates begin to appear in excess in the renal secretion. In cystine and phosphatic deposits with alkaline urine it is also useful, and has sometimes been injected into the bladder for its local effect (mij in $\bar{\text{z}}$ iv of water).

Gout.—Dr. Duncan recommended this acid as a preventive for the undue formation of lithic acid (Dub. Quart. Journ., May, 1865) by its aiding assimilation; hence it should be serviceable in chronic gout, but such a view has not been supported by the experience of others, and, as a rule, gouty subjects are very intolerant of any acid treatment.

PREPARATIONS AND DOSE.—*Acidum hydrochloricum dilutum*: dose, 5 to 20 min. freely diluted. The following preparations contain free hydrochloric acid: *Acidum nitro-hydrochloricum dilutum*, dose, 5 to 20 min., *Glycerinum Pepsini*, *Liq. antimonii chloridi*, *Liq. arsenici hydrochloricus*, dose, 2 to 8 min., *Liq. morphinæ hydrochloridi*, dose 10 to 60 min., *Liq. ferri perchloridi fortis*, *Liq. zinci chloridi*.

ADULTERATIONS.—Sulphurous and sulphuric acids, chlorine and iron.

ACIDUM HYDROCYANICUM DILUTUM— DILUTED HYDROCYANIC ACID.

(HCN or HCy = 27.)

A solution in water containing 2 per cent. by weight of the anhydrous acid; Scheele's acid contains 4 per cent., Vauquelin's 3·3 per cent.

Amygdalin, from which the acid is developed under the influence of a ferment, exists in many plants, in the leaves of the cherry-laurel, the kernels of the peach, bitter almond, cherry, etc. It occurs in some liqueurs distilled from substances containing amygdalin, as, for example, maraschino. In the mineral kingdom the acid is found in combination with metals as cyanates and cyanides; it occurs in various animal secretions, and may be obtained by heating nitrogenous organic matter in contact with a base. Scheele discovered the acid in 1782, and is said to have been accidentally poisoned by it.

CHARACTERS AND TESTS.—The pharmacopœial solution is a colourless volatile liquid of characteristic odour. Its taste has been variously described as "hot and bitter" (Taylor), or "cooling, afterwards irritating"

(R. W. Smith); sp. gr. 0.997 (v. p. 335). If free from other acid it only transiently reddens litmus. It decomposes on exposure to air and light, but that which is prepared by the pharmacopœial process and kept in dark-coloured bottles may be retained for years without perceptible change. Stronger solutions alter more readily, and of the anhydrous acid (which has a sp. gr. of 0.697) a part evaporates on paper so quickly as to freeze the rest. Cyanides prevent fermentation, and are fatal to vegetable life (Dumas).

ABSORPTION AND ELIMINATION.—Hydrocyanic acid is absorbed to some extent, even through the unbroken skin, especially if a strong solution be applied with friction; from a wound, or from mucous membrane, it is, however, absorbed much more readily. When placed on the tongue or swallowed in the ordinary way, it passes sooner into the circulation than when injected into the stomach, rectum, or vagina (Coullon, Krimer). In less than thirty-six seconds after a little of the strong acid is placed on an animal's tongue it may be detected in the circulating blood (Krimer, Horn's Archiv, 1826); after intravenous injection, also, it quickly produces its effects, but most quickly after inhalation. Guinea-pigs made to inhale the anhydrous acid for one second die within fifteen seconds, and strong rabbits exposed to the vapour for three seconds are destroyed within thirty (Preyer, Die Blausäure). The weakly, the young, and the aged amongst warm-blooded animals are much more easily affected by the acid; whilst frogs and all cold-blooded creatures, are much less sensitive to its action, and survive toxic doses for several hours. Horses are said to be insusceptible to quantities of one or two ounces (Amory).

Although so rapidly poisonous to most animals and to men, absorption must precede any general action, and Stillé has shown that if a tight ligature be placed round a limb exposed to the acid, constitutional effects do not occur, so long as the local is cut off from the general circulation. Blood is not essential to its action, for the bloodless "salt frog" exhibits the same symptoms under prussic acid as the normal creature (Lewisson, Reichert's Archiv, 1870).

Elimination is rapid, and with medicinal doses is probably complete within an hour; even after a full or poisonous amount, if life can be prolonged for that time, recovery may be hoped for (v. p. 331). The acid passes out partly by the saliva, to a slight

extent by the kidneys, but mainly by the lungs, as evidenced by the characteristic odour of the breath. Hydrocyanic acid is eliminated partly as sulphocyanides in the urine.

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—Small medicinal doses—2 to 5 min. of the official acid—seldom exert more than a transient sedative effect on the gastric mucous membrane; 10 to 20 min. induce slight local irritation of the fauces and stomach, with increased flow of saliva and nausea; breathing the vapour, or taking by the mouth 20 to 30 min. or more of the diluted acid, causes such symptoms in a marked degree, though not always immediately (Taylor). According to Batelli the hypodermic injection of hydrocyanic acid diminishes the peristalsis of the stomach.

Toxic Action.—Hydrocyanic acid is a general protoplasmic poison. The metabolic activity of both animal and vegetable tissues is arrested or at least diminished by its action. In animals under doses not rapidly fatal, there occur vertigo and loss of muscular power, with slow breathing and quick weak pulse: later, general convulsions, protruding eye-balls, lividity and death from asphyxia, or gradual recovery. *Post-mortem* congestion of venous trunks and cerebral membranes is marked.

In man, more than 60 min. of the dilute, or 1 gr. of the anhydrous acid, is usually a fatal dose, though symptoms may not be developed for some minutes; after as much as $\frac{1}{2}$ fl. oz., however, they will come on in a few seconds, or even during the act of swallowing. Volition and power may be retained just long enough to walk a few paces, to arrange the bed-clothes, or to cork a phial; but suddenly the subject, if standing, will fall prostrate, often with a scream, or in convulsions. Within two minutes he will be insensible, paralysed, with fixed and glistening eyes, dilated insensible pupils, cold clammy skin, and swollen cyanotic face: the jaw is set, saliva exudes from the mouth, and evacuations occur from the bladder and bowel: the breathing, at first perhaps hurried, soon becomes convulsive and gasping, with long pauses and prolonged expiration: the pulse, after a brief quickening, is soon imperceptible, and death occurs from asphyxia within three to five minutes after the fatal dose. The glistening condition of the eye usually described, and the evacuation of the bladder and bowel, are not so constant as commonly supposed:

in four cases within my experience, the former symptom was not present, and in only one did the evacuations occur.

Respiratory System.—In man medicinal doses do not affect respiration, but 10 to 20 min. may render it irregular and laboured. Under small doses, the rate of breathing in animals either remains unaltered at first or is markedly lowered. With larger doses and concentrated solutions, the course of poisoning is so rapid that the respirations can scarcely be counted; convulsive movements also interfere with observation, but we can say that in this stage the rate is lowered, and continues so. As the animal passes into a comatose condition, a slight rise may occur, which increases if recovery is proceeding, but which soon gives place to marked slowing and then complete cessation of breathing. The heart may continue to beat for some little time after this, and if so, even if in other respects the animal seems dead, *artificial respiration* will restore it to life.

The general character of the respiratory changes resembles, not that occurring in apnoea, but that which occurs when the vagi are divided and the central end stimulated by electricity (Preyer). At the beginning of the poisoning the inspirations are deeper than normal, then follows a pause, and then short shallow expirations. In many instances during the convulsive stage there occurs on inspiration a tetanic spasm of the diaphragm, such as Traube found after direct vagus irritation.

Nervous System.—Doses which disturb the digestive and circulatory systems—10 to 20 min. of the dilute acid—may cause giddiness, a sense of constriction and heaviness of the head, prominence of the eyes, some confusion of intellect, and muscular weakness. Impaired vision and hemiopia have followed inhalation of the acid used in cleaning lace (B. M. J., i., 1884). Upon which part of the nervous system the special effects of larger doses are exerted—whether upon the vagus, the nerve centres, or the peripheral nerves—is disputed.

Vagus Nerve.—Arguing from the conditions already described, and from the fact that poisoning by prussic acid is most rapid when the vapour is inhaled, Preyer concluded that its chief action is exerted on the terminations of the vagus in the lungs, the irritation being propagated to the respiratory centre, and causing the phenomena of asphyxia. That the stimulation is not, in normal

conditions, exerted directly on the respiratory centre is evident from the fact, already noted, that section of the vagi—*i.e.*, interruption of communication between the ends and the centre—delays the course of the poisoning and the time of death¹: the occasional occurrence of tetanic spasm of the diaphragm is explained by a secondary transfer of irritation from the medulla to the *phrenic nerve*. In animals with divided vagi, the respiratory changes are somewhat different, and death in such cases is explained either by an action on the terminals of other nerves of the lungs, or by direct action on the centre in the medulla, or, when occurring under large doses, by direct paralysis of the heart.

Nerve Centres.—Boehm and Knie conclude that the main change is exerted on the *central* nervous system—the medulla—the functions of which are for a brief period stimulated and then destroyed (*Archiv f. exper. Path.*, ii.). In cats prepared for experiment according to their method, there occur under prussic acid at first two to four deep laboured inspirations, then quick and convulsive expiration, “resembling that caused by irritation of the superior laryngeal nerve” (Rosenthal); they observed no inspiratory cramp or tetanus, and no influence of the vagi, whether it be left entire or divided, upon the course of the poisoning, nor upon the heart. The practical result is that these observers attach no value to atropine as an antidote, though equally with Preyer they recognise the excellent results to be obtained by artificial respiration.

I am not prepared to reconcile the differences between these and other observations, but Preyer attributes the differences to undue manipulation of the animals, maintains his conclusions unaltered, and offers additional facts in support of some of them (*Archiv f. exper. Path.*, 1875). Lecorché and Meuriot, whilst agreeing with him that cyanic death is connected with intense excitation of the vagus nerve, and that section of the vagi delays it, attribute such excitation to a central, not peripheral, action of the poison. A striking experiment made by Prof. Jones bears in the same direction: having found, with alligators, that the

¹ This is interesting in connection with the fact recorded by Dr. Embley that when the heart-action is inhibited under chloroform, it may be restored by section of the vagi (in animals), or by injection of atropine in men (*v. p.* 330), (*B. M. J.*, i., 1902).

internal giving of the poison did not easily or quickly take effect, he applied it *directly* to the medulla oblongata, and within sixty seconds there followed expiration of the air contained in the lungs, with collapse of those organs, and tetanic contraction of the respiratory muscles (New York Med. Record, vol. ii.).

The convulsions which often occur in cyanic poisoning are *cerebral* in origin, for they do not occur in parts situated below a transverse section of the spinal cord—*i.e.*, in parts with which cerebral communication has been interrupted (H. C. Wood). They are connected with disturbed cerebral circulation, for they have been noticed to commence directly after cardiac arrest (Laschkewitsch, Coze). The convulsions, though resembling those of asphyxia, differ from them in the circumstance of the blood being red (or non-venous), and in not being improved by artificial respiration (Brunton).

Peripheral Nerves and Muscles.—We are unable to conclude positively with Preyer that the peripheral ends of the vagus receive the first and main influence of the poison, for the mere extent of absorbing surface and ready contact with blood in the lungs would go far to account for the greater rapidity of the effects of inhalation, and there is other evidence that the respiratory *centres* are affected. This question, however, apart, we may accept the careful observations of Kölliker, that peripheral sensory nerves are paralysed by *local contact* with sufficiently strong solutions, and the early disappearance of reflex function in cyanic poisoning is connected with such paralysis rather than with paralysis of the cord (Kiedrowski), although the spinal cord is affected later. Nerve-tissue placed in a solution of prussic acid loses its conducting power, and muscular tissue loses its irritability still more quickly, although the nerve-trunks are probably acted upon at the same time as the muscles after internal administration of the acid (Virchow's Archiv, Bd. x.). When the whole blood is rendered venous, as in later stages of poisoning, there is increased action of the involuntary muscular tissue, and hence, often increased peristalsis of the intestine, contraction of the bladder, and evacuations from those viscera. The same result occurs sometimes in asphyxia from hanging, carbonic acid poisoning, etc., and is commonly attributed to the same cause (venosity

of blood). Medicinal doses of hydrocyanic acid do not affect the temperature of the body, but toxic doses cause a rapid fall.

Circulatory System.—Continued small doses—1 to 5 min.—given at moderate intervals of two to four hours, lessen the force and rapidity of the heart-action; 10 to 20 min. taken by the mouth, or inhaled, may cause giddiness and faintness, with slowing, or sometimes quickening, of the pulse, and suffusion of the face. With animals, full or large doses cause a sudden arrest of the heart in diastole; this continues for a variable time, and is followed by quickened action, and afterwards by diminution, and then by either gradual return to the normal number of beats, or total cessation, according to the dose, and to the age and strength of the animals.

A point of much interest is the statement that *section of the vagi* in the neck prevents this primary diastolic arrest, and Preyer affirms that after such section no slowing of the heart's action occurs under doses that would with uncut vagi stop the heart (*op. cit.*); also that death under toxic doses is much slower when these nerves are divided than when they are not. We know from Pflüger's researches that weak stimulation of the vagus causes slowing of the heart, and a very strong stimulus of it causes stoppage in diastole, and Preyer argues that the action of prussic acid on the heart is exerted through the *vagi* in accordance with these results, and the secondary and temporary quickening which occurs with certain doses is due to a secondary paralysis of the controlling influence of the same nerves.

On the other hand, we have directly contradictory observations upon cats by Boehm and Knie, who found no primary diastolic arrest, and no influence exerted either way by section of the pneumogastriacs; but their animals, though more accurately dosed, were in a still less natural condition than those of Preyer, for they were chloralised and tracheotomised, and the acid injected through an exposed jugular vein; we cannot think their observations conclusive.

With lethal doses death is instantaneous, and the heart is arrested in diastole without any recurrence of ventricular contraction, though some movement of the auricles may be perceived on opening the chest (Lecorché and Meuriot, *Archives Gén.*, t. xi.);

with such doses the result is not influenced by section of the vagi, and death is presumed to follow direct cardiac paralysis (Preyer). Applied directly to the heart, the acid arrests its movement and destroys its muscular irritability.

Arterial pressure in the vessels is said to be increased under the action of prussic acid (Wahl), but such increase is temporary only; the pressure soon falls below normal, and after large doses remains so for some time; this is accompanied by slowing of the pulse. The rise in blood pressure is due to stimulation of the vaso-motor centre.

The startling rapidity of action of prussic acid suggests an immediate toxic effect on the *blood*, and there is indeed a remarkable colour-change induced, which has been thought to give a clue to the intimate working of the poison. Thus, if the jugular vein of a rabbit be exposed, and seen to contain dark blood, and a toxic dose of acid be then given by the mouth, so soon as convulsive movements indicate its taking effect, will the stream of venous blood take on a clear red colour, and the vessel greatly enlarge in size. If the blood be let flow from an incision, a similar change is observed, and if the right heart be examined *in situ*, the dark blood contained in it is equally seen to become red; it is so also in the nose and ears (Gaehtgens, Med.-Chem. Untersuch., Berlin, 1868). This has been noticed, though with less detail, by earlier observers, by Claude Bernard (who obtained a similar result with carbonic oxide), and by Preyer who found the same appearance caused not only by diluted sulphuretted hydrogen, but also by the mere removal of any obstructions placed in the air-passages. It is not, therefore, due to a specific action of prussic acid. The apparently contradictory observations of Bischoff and others, to the effect that all the blood found in the body after cyanic poisoning is unusually dark and venous, are explained by a difference mainly in the *rapidity* of the poisonous action; if life be prolonged for a few minutes, the red colour is gradually replaced by dark, whilst if death be very sudden, red blood only is found in the heart—sometimes even on the following day. In cold-blooded animals the red colour persists much longer than in the warm-blooded.

Theories of Action.—It is easier to ascertain than to explain these facts. Hoppe-Seyler suggests that the acid enters into

loose combination with hæmoglobin, and that the red corpuscles lose for a time their power of giving up oxygen in the capillaries—that oxidation of tissue is suspended (Med.-Chem. Untersuch., 1866). Geinitz argued that a change in the *physical form* of the corpuscles would explain change of colour, and found that the acid mixed with blood *outside* the body caused various alterations of their form (Pflüger's Archiv, Bd. iii., 1870); but according to Preyer the blood of a poisoned animal taken from the vessels directly after death, and examined by the microscope, exhibits *no change* in the character of the corpuscles (Chemismus, Leipsic, 1840). He inquires whether the deepened breathing could for a time induce a hyper-oxygenated condition as in animals dying from apnœa and found by Pflüger to have bright red blood (Archiv, i., p. 106), or whether the increased blood-pressure could drive the blood so quickly through the capillaries as to prevent its giving up oxygen as usual. Kobert states that a new hitherto undescribed combination of methæmoglobin with cyanogen is formed (Ueber Cyanmethæmoglobin, 1891), and after death by hydrocyanic acid the parts in which hypostatic congestion occurs have the characteristic bright red colour of this compound.

I cannot satisfy myself as to a clear explanation, but believe that during the first stage of cyanic poisoning oxidation is arrested, and that the venous condition of blood found in later stages of poisoning is connected with spasm of the pulmonary arterioles, and paralysis of the respiratory and cardiac muscles (asphyxia).

It would seem that no *permanent* toxic combination is formed with the corpuscles; they are not at once fatally spoiled, nor is oxygen wholly driven out, but for the moment (and it may be finally) its interchange with tissues is prevented. The results of many careful spectroscopic examinations by Preyer and others, and of many laborious gas analyses by Gæhtgens, confirm this view; the red blood shows still the absorption bands of oxyhæmoglobin, and the dark blood those of hæmoglobin; although outside the body, prussic acid forms a new compound, cyanohæmoglobin, it apparently does not do so during life. Laschkewitsch could not detect such compound, but, on the contrary, found oxyhæmoglobin (Reichert's Archiv, 1868), and Hiller and Wagner, examining blood whilst still within the mesenteric vessels, obtained

characteristic though feeble lines of oxyhæmoglobin (Lancet, ii., 1877). If withdrawn from the body, the dark blood, shaken up with oxygen, resumes its normal red tint, and—a most important practical point—the condition just described may be remedied during life by securing access of additional oxygen by *artificial respiration*. This is in distinct contrast with what occurs in poisoning by carbonic oxide, in which case a new compound, carboxyhæmoglobin, with well-marked chemical and physical properties, is undoubtedly formed.

Gæhtgens proved (1) that the property of de-oxygenated blood to abstract oxygen from surrounding media is not destroyed by prussic acid; (2) that blood saturated with oxygen exposed to the action of prussic acid gives off no oxygen, and that substances which would usually withdraw oxygen from fresh blood do so with much difficulty under the influence of the acid. Both oxygen and carbonic acid are excreted in less than normal *total* quantity during the poisoning (on account of the slow rate of the breathing), but not only is the actual percentage of carbonic acid in the expired air less than normal, but the *percentage* of oxygen in the same expired air is greater than normal, *i.e.*, it has not been used up in the system. According to Geppert the acid produces so profound an effect on the protoplasmic structure of the cells that they are unable to utilise the oxygen of the oxyhæmoglobin, and it therefore remains unreduced. This effect on tissue protoplasm is however transient if the toxic supply is not continued and the original dose is not fatal.

SYNERGISTS.—Cyanides, cherry-laurel water, and essence of bitter almonds owe their activity and chief properties to prussic acid, and exert a similar action.

ANTAGONISTS.—INCOMPATIBLES.—The effect of medicinal doses is lessened by diffusible stimulants, by strong acids or alkalis, and by opium (Gubler). Warmth quickly volatilises the acid, otherwise it favours its action. The most reliable antidote to poisonous doses is *oxygen*, which may be introduced into the system by *artificial respiration*, or by direct inhalation.

Preyer strongly recommends atropine as a “dynamic antidote,” since it acts upon the vagus nerve in a manner contrary to that of hydrocyanic acid. I must agree with Boehm and others that his observations are wanting in scientific accuracy, as when he speaks

of injecting "a little atropine," or says simply, "Injected sulphate of atropine, and afterwards a rather large dose of prussic acid, which would assuredly have caused death"; still they hold true to a certain extent. A practical difficulty in their useful application must always be the extremely rapid course of cyanic poisoning, and the (comparatively) slow diffusion of atropine; to be of any service, the alkaloid would have to be used almost on the instant of poisoning (*cf.* p. 325). Chlorine and chlorine water have been used with advantage by A. Chevallier and Orfila, but they are not manageable. Turpentine, though recommended as a specific antidote, has value only as a stimulant. Some indefinite evidence exists as to an antidotal power possessed by strychnine. Thus, a puppy that had taken $\frac{1}{2}$ gr. of prussic acid quickly recovered after swallowing a dose of the alkaloid (*Med. Times*, ii., 1859), and some other instances are reported (*Lancet*, i., 1868). Silver and metallic oxides, generally, form insoluble compounds with prussic acid, and fresh carbonate of iron has been recommended (*Med.-Chir. Trans.*, ii., 1865); practically, however, their influence can scarcely be exerted quickly enough.

It remains that *artificial respiration* is the main resource in all forms and stages of cyanic poisoning—it may be carried out in the ordinary methods, or excited by the sudden affusion of water, first cold and then hot, thrown over head and chest, or pure oxygen gas may now, perhaps, be available for inhalation. This does not exclude the use of an emetic, the application of ammonia to the nostrils, or even its injection into the veins, or the hypodermic use of brandy and ether, whilst stimulating frictions and warmth should be applied to the limbs; by the steady use of these means, patients have been revived from apparently hopeless insensibility, and if life can be prolonged for an hour, the chances of recovery become greatly increased.¹

THERAPEUTICAL ACTION. — *External.* — **Urticaria.** — **Prurigo.**—I have seen great relief given, in obstinate forms of these maladies, by lotions containing hydrocyanic acid in sufficient strength. Pereira states that he did not observe benefit in such cases, but he seems to have used only 2 dr. of acid in $\frac{1}{2}$ pint of

¹ When immediate danger from collapse or apnoea is past, treatment should be directed to the probable congestion of the stomach or brain.

water. I have recommended $\frac{1}{2}$ oz. or more in 10 oz. of liquid (rose water), and have never seen ill effects; but such a remedy should not be placed in careless hands, nor ordered if the skin be excoriated: *sometimes* a much smaller proportion will answer well, and especially when mixed with lead lotion. The cyanide of potassium has also been used for lotion and ointment in the strength of $\frac{1}{2}$ dr. to 8 oz. of liquid, or 1 oz. of cerate; a greater strength has caused severe irritation.

THERAPEUTICAL ACTION.—*Internal.*—Hydrocyanic acid has a certain value in relieving spasmodic pain and irritation, but its use is limited by the extreme care required in dosage, and the risk of causing unpleasant symptoms; yet, to say with Trousseau that “it is often dangerous, almost always useless, and very rarely curative,” overstates the facts.

Gastrodynia.—**Enterodynia.**—Cases described under these names, which seem to be frequently of neuralgic type, are often quickly relieved by suitable doses of prussic acid. Pereira gives instances of severe spasmodic pain, without pyrexia, faintness, or ordinary symptoms of dyspepsia, but such as to cause suspicion of organic disease, had it not disappeared under the use of the acid. In one case it was seated in the intestine, came on about two P.M., and lasted until night, unrelieved by many remedies until this one was used; Pereira observed that its action is exerted quickly, and either produces complete relief or none at all. Sir T. Watson “has seen more rapid and decided relief from it in gastrodynia than from anything else.”

Dyspepsia.—Dr. Elliotson, in a special treatise on the subject, makes several groups of cases in which he found prussic acid extremely useful; some were marked by pain and tenderness only, others by flatulence, nausea, anorexia, liver troubles, and vertigo, others again by pyrosis, heartburn, and palpitation (Med.-Chir. Rev., 1821). A. T. Thompson made somewhat similar observations, especially noting benefit when the tongue was hot, red, and sore (Dispensatory). Bailey also published illustrative cases (London Med. Repos., 1828), and alluded to its value when there was sympathetic heart-disturbance, palpitation, etc. In such cases it is still in frequent use, although other remedies may be required if there be marked symptoms of unhealthy secretion. Disappointment as to its effects may be sometimes traced to the

inertness from age of the preparation, or to admixture with other drugs.

Vomiting.—The acid is useful in the vomiting of fever, and in reflex vomiting, and is sometimes indicated in that of ordinary gastric derangement: it may be added to effervescent or bismuth mixtures, but as a rule is better given alone in distilled water. In some patients, or in some conditions, and more especially when the dose is too large, nausea and vomiting seem to be increased or caused by the drug, and then it is better omitted: on the other hand, I have seen severe cases recover with 6 to 8 min. doses, when smaller doses and all ordinary means had failed. Brinton found the acid useful in the vomiting of gastric ulcer, and it has proved so in gastric cancer. Pereira recommended it in the vomiting and purging of phthisis, and even of cholera, and it may well be tried in the “nervous” form of vomiting, that connected with pregnancy, or with cerebral concussion or disorder.

Phthisis.—In the early part of this century, Dr. Granville published a small treatise “to establish the claims of a new and powerful remedy,” and in his second edition (1820) congratulates himself on the conclusive and numerous facts which have proved he was “not indulging in the chimeras of a revery” when he recommended prussic acid for treating consumption. The exaggerated views entertained both by him and by the eminent Majendie as to its powers of checking the disorder and curing asthma, chronic cough, etc., have not been verified by later experience. We can only say that it is a useful palliative for the irritative dry cough, especially in cases where morphine is not suitable, and that with alkalies and calumba it is often serviceable in phthisical dyspepsia. The vapour of the acid is sometimes used to lessen irritability of the respiratory passages and cough.

Whooping-Cough.—“**Nervous Cough.**”—Dr. Granville states, “without presumption,” that in almost every case of whooping-cough this medicine, given early, removes the disease, and Dr. Hamilton Roe, in a special treatise (1838), records equally excellent results. He was rather in advance of his time in concluding pertussis to be not always inflammatory, but “a nervous affection, having its seat in the mucous membrane of the bronchi and the pneumogastric nerve,” and for the “nervous element,” *i.e.*, the peculiar whooping or spasmodic cough, he valued prussic

acid more than opium, belladonna, or any other remedies then in use: he gave very full doses, such as $\frac{3}{4}$ min. of Scheele's acid to infants, and $1\frac{1}{2}$ drop every quarter-hour for twelve hours to a child of ten years: but I agree with Sir T. Watson, who thinks such doses "too gigantic for such young subjects". Dr. C. West, found it "sometimes magical" for diminishing the frequency and severity of the paroxysm, but sometimes inert, sometimes poisonous. Dr. Atlee, judging from 200 cases, gave a most favourable report of it (Amer. Journ., vol. x.), and my own experience is in the same direction—the more purely nervous the paroxysms the better will the remedy act, though some difficulty in graduating its dose will always remain: the results obtained from remedies vary in different epidemics and different individuals, and antiseptic vapours and applications should not be omitted. In other forms of irritative cough, connected with spinal or vagus irritation, I have seen more benefit from this acid than from any ordinary sedatives; and the long-recognised clinical value of the drug in such conditions is of marked interest, taken in connection with the special effect on the medulla and vagus, mentioned under Physiological Action.

Asthma.—Much relief may be given to patients suffering from simple spasmodic asthma by small and repeated doses of prussic acid.

Palpitation.—Whether palpitation arises from cardiac hypertrophy or from ordinary functional derangement of the heart dependent upon nervous exhaustion or dyspepsia, hydrocyanic acid or remedies containing it will often prove useful.

Vertigo.—Cerebral Irritation.—Mania.—The acid certainly exerts some control over disordered cerebral function, whether by acting through the circulation or otherwise. Vertigo, especially if dependent on gastric derangement, may be relieved by it. Dr. M'Leod has furnished evidence of its calmative power in acute mania and acute melancholia, recording forty cases, in most of which the relief given to violent excitement was marked and rapid; about 5 min. of Scheele's acid was the usual dose, or 3 min. injected under the skin (Med. Times, i., 1862).

PREPARATIONS AND DOSE.—*Acidum hydrocyanicum dilutum* (contains 2 per cent. of anhydrous acid): dose, 2 to 6 min. As a lotion, 2 dr.

to 1 oz. in $\frac{1}{2}$ pint of rose water; it should not be applied to an abraded skin. It is also contained in *tinctura chloroformi et morphineæ*, *aqua laurocerasi*, and some non-official remedies. In prescribing hydrocyanic acid in mixtures it should be remembered that its specific gravity is low, and it therefore tends to rise; thorough shaking of the mixture in the bottle should be enjoined.

ACIDUM NITRICUM—NITRIC ACID—AQUA FORTIS ($\text{HNO}_3 = 63$).

Nitric acid, the highest known oxide of nitrogen, may be detected in the atmosphere after thunderstorms, for electricity determines the necessary combination of the gases. United with potash, soda, lime, or ammonia, it forms nitrates which are found native in efflorescence on the soil of some countries; its salts occur also in some minerals and in certain plants. The pharmacopœial acid contains 70 per cent. by weight of nitric acid: the dilute acid is about a fifth part the strength of the concentrated acid.

CHARACTERS.—The pure acid, protected from light, remains colourless, but if exposed becomes yellowish, from development of orange-coloured oxides; with a sp. gr. of 1.42 it is a stable compound, boils at 250° F. and distils over unchanged; it has a very sour, corrosive taste, and an acrid, suffocating odour; its affinity for water is great, and the white fumes which it emits on exposure are caused by the combination of its invisible vapour with atmospheric moisture, forming a cloud of minute drops. Nitric acid is a powerful oxidising agent, and is used to prepare the nitrates of different metals; also for the making of certain organic compounds, as gun-cotton, nitrite of amyl, nitro-glycerin, etc.

ABSORPTION AND ELIMINATION.—Dilute nitric acid in medicinal doses is readily absorbed. In the blood it either combines with alkaline bases forming nitrates, or it circulates, loosely joined with albumin (Gubler): it cannot be detected *free* in the blood. It is eliminated mainly by the urine as nitrate of potassium or sodium. From its effects upon the intestinal glandular structure, and from the comparatively small amount passed in the urine, it is probable that some is excreted by the lower bowel.

PHYSIOLOGICAL ACTION.—*External.*—Strong nitric acid applied but for a moment stains organic tissue yellow, and leads

to desquamation of the epidermis. The yellow colour is due to the so-called nitro-substitution-products it forms with albuminous materials or proteids in the tissues. This colour is turned orange by the addition of ammonia, and forms a delicate test for proteids: it is known as the xanthoproteic reaction.

Dilute solutions exert a stimulant, moderately astringent effect; by continued contact they change most animal and vegetable substances into oxalic, malic or carbonic acids. Nitric peroxide is an efficient but irritating disinfectant.

PHYSIOLOGICAL ACTION.—*Internal.*—For a general statement as to the action of acids on the organism, reference may be made to hydrochloric acid.

Digestive System.—Given internally, in medicinal doses, dilute nitric acid exerts a stimulant effect on the glandular system of the alimentary canal, and some tonic bracing effect on the mucous membrane, so that appetite is improved by it, and undue secretion lessened; this is probably owing to a direct local action. Salivation sometimes occurs under the use of nitric acid, either in consequence of the gastric irritation, or of direct stimulation of the salivary glands by the medicine. It is commonly credited with some power of stimulating the secretion and excretion of bile. Like other acids, it exerts an antiseptic action.

Large doses act like other corrosive irritant poisons. In a case that proved fatal on the eighth day after swallowing 1 dr. of the strong acid, the œsophagus and stomach were found inflamed and ulcerated, the colon was in the same state, but the small intestine was sound; suppression of urine had occurred.

SYNERGISTS.—**ANTAGONISTS.**—The same as those of sulphuric acid.

THERAPEUTICAL ACTION.—*External.*—**Disinfectant.**—Nitrous fumes may be generated by the action of sulphuric acid on nitrate of potash. They efficiently disinfect unhealthy wards, prisons, etc., but the use of less irritating substances has practically replaced this method.

Phagedænic Ulceration.—In cases of sloughing chancre, phagedæna, hospital gangrene, cancrum oris, etc., when it is necessary to destroy portions of diseased tissue, and to stimulate to healthy action, strong nitric acid is one of the best caustics. The affected part should be cleansed and dried so that the acid

be not too diluted by secretion, the neighbouring parts should be protected by oil or ointment, and the caustic applied with a glass brush, splinter of wood, or pledget of lint, until a firm dry yellowish mass is formed; the pain is at first severe, but soon subsides under cold water dressings; the eschar formed is not very deep, and usually separates in one or two days; the application may require to be repeated.

Bubo.—The strong acid may, with advantage, be lightly pencilled over torpid suppurating buboes, to destroy the integument and stimulate to healthy discharge; should a sinus be formed, the upper wall should be touched in the same manner.

Uterine Disease.—Dr. Lombe Atthill has had the best results from the same application to the interior of the uterus, in cases of fungoid granulation and excessive hæmorrhage: lint bound on a uterine probe conveys the caustic through a small speculum placed in the cervix. It is a good application also in chronic inflammatory disease of the same part and in granular erosion of the cervix, if there be not excessive tenderness (B.M.J., i., 1876). H. Lee found the acid good in uterine disease, if the mucous membrane be not too much thickened; it is important that it be not diluted by secretion, and that an alkaline injection be used after it (Lancet, i., 1874). As injurious effects have sometimes followed the use of nitrate of mercury, and of strong iron solutions, I prefer nitric acid for vaginal and uterine diseases of the kinds named, but in cases of hæmorrhage from the vagina or uterine neck, connected, *e.g.*, with carcinoma, the perchloride or persulphate of iron mixed with glycerin, are better hæmostatics. It has been used as a test in surgical operations for cancer, its differential staining reactions showing when all the malignant tissue has been removed.

Internal Hæmorrhoids.—It has been thought that strong nitric acid would supersede all operative interference in this disorder, but its curative power is somewhat limited.

Its local application is only useful in small granular piles, and in "velvety" conditions of the mucous membrane; it checks the bleeding, but severe hæmorrhage may occur when the slough separates. One or two applications ought to suffice for the cure of such a condition, but for large masses, or for hæmorrhoids with narrow vascular attachments, other treatment is better. Billroth

reported much success with nitric acid in internal hæmorrhoids, especially in the flat form: after protrusion, he applied the remedy till the part was "stiff and yellowish-grey in colour," and then oiled it well—not touching sound parts with the acid, for it causes great pain (Ranking, i., 1872). Dr. Houston first proposed this treatment (Dub. Med. Journ., vols. xxiii.-xxvi.), and Mr. Henry Smith used it extensively. In less severe cases where the parts bleed and are somewhat swollen, Dr. Ringer recommends a lotion containing 1 to $1\frac{1}{2}$ dr. of dilute acid to $\frac{1}{2}$ pint of water: the same is suitable for any indolent ulceration.

Prolapsus Recti.—If the strong acid be applied in one or two horizontal bands to prolapsed mucous membrane of the rectum, in such a degree as to cause moderate sloughing, these bands will leave cicatrices, which, by their contraction, are often sufficient to cure the complaint. In children benefit may be obtained from bathing the part with a weak nitric acid lotion, and giving the same acid internally.

Warts, etc.—Sir Erasmus Wilson recommended nitric acid for the treatment of callosities, the cauterised portion being removed occasionally by the knife. I have used it extensively for the removal of moles on the face; the cicatrices are hardly visible. It may be applied also to condylomata, and to dog and snake bites.

Nævi.—Superficial nævi may be safely destroyed by painting with strong nitric acid; Mr. T. Holmes speaks highly of this method. Due precaution should be taken to protect the sound skin, and an alkaline lotion should be used afterwards. If the affected part be extensive, a portion only should be treated at one time, the caustic being applied about every second day, until its full effect be produced (Lancet, ii., 1866 and 1867). For small nævi on the face, I can recommend puncture with a needle dipped in the acid: it is safe, effective, and leaves comparatively little scar.

Pruritus.—A similar lotion will often relieve itching in papular and neurotic diseases, such as lichen and prurigo; it may be conjoined with prussic acid, or with the liquor carbonis detergens.

Alopecia.—The acid, diluted with so much olive oil as will prevent the caustic though not the stimulant effect, makes a good liniment in some cases of falling off of the hair from debility.

THERAPEUTICAL ACTION.—*Internal.* — **Dyspepsia.** — **Debility.**—Dilute nitric acid is a serviceable tonic in cases of nervous debility and of convalescence from acute disease, when appetite and digestive power are impaired. It acts well in combination with a few minims of tincture of *nux vomica*, stimulating the gastric glands and the biliary secretions, and may be given between meals, or shortly before or after, according to the conditions already mentioned under hydrochloric acid.

Hepatic Disorder.—Nitric acid has long been held in repute for the treatment of chronic hepatic congestion, or chronic hepatitis, especially when occurring in Anglo-Indians, and after mercurials have been used. Dr. Hutchison met with marked improvement, even in cases of *waxy liver*, from the continued use of nitric acid with vegetable bitters, but in later writings he remarks that there is no evidence of its assisting the flow of bile, and that its action is less direct than that of alkalies; that in congestion (of acute character), or when lithiasis is present, it either does no good, or aggravates the malady, though it may relieve the dyspepsia of debility: he sometimes gives alkalies before a meal, and acid after (B. M. J., i., 1874). Sir R. Martin, Thudichum, and indeed the majority of writers thirty years ago, allowed to nitric acid a larger sphere of usefulness in hepatic disorder, jaundice, etc.; it was presumed to “lixivate biliary deposits, tone digestion, and act antiseptically” (B. M. J., ii., 1860). Annesley noted that it acted better the more freely it was diluted—he used it in chronic splenic disorder. I have found it useful in chronic hepatitis, when watery diarrhœa and constipation occur alternately. It is specially good in that form of dyspepsia known as biliousness, but the general opinion is that the nitro-hydrochloric acid is better.

Phosphatic Urine.—**Chronic Cystitis.**—Sir B. Brodie constantly employed nitric acid, in full doses, largely diluted, for phosphatic and alkaline urine. In cases of chronic cystitis, and even of phosphatic calculus, he also employed local injections containing 1 to 2 min. of the strong acid in the oz. of warm water. The best mode of administering dilute nitric acid under these conditions is to give 5 to 10 min. in 1 or 2 oz. of decoction of *pareira* every three or four hours.

Diarrhœa.—When the dejections are frequent, serous or

“ watery ” in character, especially if markedly alkaline, and if there be no evidence of acute inflammation and not much pain, then nitric acid acts well, and in cases of profuse purging from summer heat, and in the diarrhœa of phthisis, it has a deserved repute; if necessary, it may be combined with a small quantity of opium, —also in dysenteric diarrhœa with tenesmus, blood, and profuse discharge of mucus.

Constipation.—Dr. Graves says: “ In constipated habits I have occasionally derived very remarkable benefit from the use of nitric acid given in sufficient doses. It seems, like the carbonate of iron, to possess the advantage of combining tonic with aperient qualities ” (Clin. Medicine, ii.). I think that this different action of the medicine depends upon dose, and perhaps combination: in *small* or moderate doses it is astringent, especially if prescribed with opium, but in *full* doses, especially in combination with a bitter infusion, such as gentian, it has an aperient effect due either to direct intestinal irritation or to hepatic stimulation.

Purulent Ophthalmia, with ulceration of the cornea, whether of a gonorrhœal or strumous form, is much benefited by a course of 5 to 10 min. of the dilute acid three or four times a day, together with local treatment.

Secondary Syphilis.—A course of dilute nitric acid is often of service in later syphilitic cachexia, especially after mercurials have been used, and in debilitated subjects, and for salivation. It benefits ulcerations of the mouth, throat and nose, and also periosteal swellings, and may be applied at the same time in the form of bath—1 to 2 oz. for each bath.

Skin Diseases.—In chronic syphilitic cutaneous eruption, such as rupia or psoriasis, this acid has been rightly commended. In ordinary non-specific disorders, it is indicated whenever general debility is a marked symptom, and especially when nerve-power is impaired. Dr. Tilbury Fox frequently gave it, in conjunction with a bitter tonic, for psoriasis in weakly subjects.

Chronic Laryngeal Congestion.—In this malady, when brought on by excessive vocal exertion, as in singers and readers, 5 to 6 min. doses of dilute nitric acid in sugared water have been found very useful, bracing up the relaxed membrane, and relieving hoarseness; also in chronic laryngitis dependent upon a syphilitic taint, it is of much use.

Chronic Bronchitis.—I agree with some good observations made by Dr. Glover, drawing attention to the benefit obtained sometimes from nitric acid in cases of chronic catarrh and bronchitis when secretion is fairly free, when nervous exhaustion is a prominent symptom, and when ammonia and expectorants fail to relieve (Lancet, i., 1865); this fact deserves more attention than it has yet received. Dr. Glover combines nitrous ether with the acid, and sometimes tinctura camphoræ co., the precipitated camphor, etc., being readily suspended in cetraria or mucilage; in the subacute exacerbations of phthisis the acid is similarly useful. It tends in both cases to reduce the amount of the expectoration.

Pertussis.—Nitric acid has been found by some observers valuable in relieving the spasmodic recurrent attacks of cough, and lessening profuse expectoration; it may certainly be credited with tonic bracing action on the faucial and laryngeal mucous membranes. Arnoldi, who introduced this mode of treatment, ordered as much acid as would render a tumblerful of sugared water “like lemon juice,” to be taken every three or four hours. Dr. Gibb, who reported the best results, gave as much as 10 min. to infants, and 40 min. to children of ten years; and some other practitioners have used this medicine with success, but when I have ordered it as freely as could be borne, I have not seen definite benefit.

PREPARATIONS AND DOSE.—*Acidum nitricum*—*Aqua fortis*: dose, 1 to 3 min. freely diluted. *Acidum nitricum dilutum*: dose, 5 to 20 min. freely diluted. Nitric acid is also contained in the following pharmacopœial preparations: *Acidum nitro-hydrochloricum dilutum*, *liquor ferri pernitratis*, *liquor hydrargyri nitratis acidus*, and *unguentum hydrargyri nitratis*.

ADULTERATIONS.—Chiefly sulphuric and hydrochloric acids.

ACIDUM NITRO-HYDROCHLORICUM DILUTUM—DILUTE NITRO-HYDRO- CHLORIC ACID—AQUA REGIA.

CHARACTERS AND TEST.—A colourless or yellowish liquid, with the odour of chlorine, volatile, and easily decomposed by light; sp. gr. 1·074. It has the power of dissolving gold, the “king of metals”—hence its old name, “aqua regia.”

PHYSIOLOGICAL ACTION.—In its full strength this acid is irritant and corrosive; in moderate doses it has an alterative tonic action; it stimulates the glandular system, causes salivation and an increased flow of bile. Its actual chemical composition is not thoroughly known, and its difference in action from the other and simpler mineral acids has not yet been verified. It is possible that substances, such as chlorine, set free on the mixture of the two acids may have an effect different from that of the simple acids.

THERAPEUTICAL ACTION.—It is useful in many of the diseases mentioned under nitric acid, but seems to possess exceptional power to influence the liver and glandular structures of the alimentary canal.

Hepatic Disorder.—In hepatitis, not so much in the acute as in the chronic form of the malady, which usually ends in enlargement and induration, it has been praised by reliable authorities. Sir R. Martin strongly recommends its application by means of a bath, putting about $1\frac{1}{2}$ oz. of acid to each gallon of water. Two gallons represent an average quantity for a footbath, which should be used warm, and whilst the feet are immersed, the inner side of the limbs and the regions of the liver and spleen should be sponged alternately for ten to fifteen minutes altogether, or compresses wrung out of the acid may be applied. Martin recommended this bath morning and evening, but I have usually found an evening bath sufficient, and have seen excellent results from it; generally it has regulated the action of the bowels, and even produced laxative effects. Some patients are nauseated and weakened by its use, though they receive benefit; it requires watching, and smaller quantities of the acid should be tried first in delicate subjects. If it does not relax the bowels an aperient should be taken occasionally during the course of the baths.

In hepatic torpor, or chronic catarrhal jaundice, if no inflammation be present, and in *chronic dysentery* with hepatic congestion, this form of bath is also valuable, and may be conjoined with the internal exhibition of the acid; even in *cirrhosis* and the consequent dropsy, benefit has been derived from this treatment.

Nitro-hydrochloric acid may affect the tissue-change in the liver in the following way: the acid administered reappears in the urine in the form of ammoniacal salts, and the ammonia with which it is combined appears to be the representative of so much

nitrogenous waste, which instead of being converted into urea in the liver has combined with the acid and been excreted as ammonia (Lauder Brunton, B. M. J., i., 1885).

Headache, etc.—It has been found of service in some headaches, particularly the frontal variety. Whatever its mode of action, it often proves serviceable in conditions of mental depression; possibly by removing toxic products from the blood and promoting discharge of bile.

Syphilis.—In the later stages of syphilitic cachexia, when the blood-condition is impaired, and elimination by the liver and skin is often inefficient, the acid used internally and in the form of bath has been recommended; a spare but nutritious diet should be enjoined in these cases.

Rachitis.—Attention has been drawn by Mr. Brodhurst to the value of nitro-hydrochloric acid baths in rickets (*Lancet*, ii., 1868); they should be conjoined with hygienic treatment, iron and cod-liver oil.

Chronic Bronchitis.—When the expectoration is profuse and semi-purulent, sponging of the chest and trunk with the acid solution already mentioned gives much relief.

Acne Rosacea.—A lotion containing the dilute acid, 1 or 2 dr. to 8 oz. of rose water, is sometimes a useful stimulant to the affected part.

Oxaluria.—This is, in most cases, dependent on some fault in primary digestion (I have known it produced apparently by continued use of a drinking water containing much lime), and besides the renal symptoms, malaise, depression and hypochondriacal feelings accompany the malady. Relief may be given by the mineral acids conjoined with attention to diet and drinking water; and of the different acids the nitro-hydrochloric seems to be the best, as originally stated by Dr. Prout; he advised its continuance for a few weeks at a time, or until lithates appeared in the urine. Deposits of cystine are relieved by the same treatment.

Dyspepsia.—In dyspepsia or “apepsia,” connected with deficient action of the intestinal glands, accompanied with a chronic looseness of the bowels, the acid has given very good results, used in the manner directed under hydrochloric acid. In such cases it often relieves the accompanying headache, and also eructations of sulphuretted hydrogen.

PREPARATIONS AND DOSE.—*Acidum nitro-hydrochloricum dilutum*: dose, 5 to 20 min., freely diluted (it is liable to injure the teeth; they should therefore be cleansed with an alkaline wash or plain water).

Bath.—As a matter of convenience the bath may be prepared with six fluid ounces of the *dilute* nitro-hydrochloric acid added to each gallon of water in a wooden or porcelain vessel, but the more active formula of Sir R. Martin is the following: Acid. nit. fort. ʒij, Acid. hydrochloric. fort. ʒiij; mix and allow to remain together for at least twelve hours; afterwards add 5 oz. of water. Of this mixture 3 oz. should be used for each gallon of water: two gallons are an average quantity for a foot bath. The bath may be kept in use for several days by adding $\frac{1}{2}$ oz. of acid solution and 1 pint of water each time to compensate for evaporation, warming only as much as is necessary (96° to 98° F.). The towels and sponges used should be kept in cold water during the intervals.

ADULTERATIONS.—Chiefly sulphuric and hydrochloric acids.

ACIDUM LACTICUM—LACTIC ACID

($C_3H_5O_3 = 90$). (*Organic.*)

The official lactic acid contains about 25 per cent of water. It occurs naturally in willow bark, and in sour milk, and in many vegetable products that have turned acid.

CHARACTERS AND TESTS.—It is a nearly colourless syrupy liquid, with an acid taste and reaction, the sp. gr. being 1.21. It is soluble in water, alcohol and ether, but scarcely in chloroform; it coagulates albumin. When strongly heated, it decomposes and burns with a suffocating odour. Treated with hot potash solution, the acid should not change colour; if browned, extractive matters are present. Acetic and butyric acids are recognised by their odour. The ordinary tests for lead, zinc, calcium and the mineral acids are applicable.

Lactate of Calcium is an opaque, white, crystalline powder, soluble in water when freshly prepared only.

Lactate of Iron is in greenish-white crystals; it is readily absorbed and well borne.

Lactate of Quinine is a granular, white amorphous powder: solubility 1 in 10.

Lactate of Strontium is also white, crystalline and soluble.

Lactate of Zinc occurs in white crystalline pieces of metallic taste, soluble in water, not in alcohol; is well borne by the stomach.

ABSORPTION AND ELIMINATION.—In the digestive tract, lactic acid is readily absorbed, and is eliminated mainly by the perspiration and urine, which secretions are rendered more acid by it; the alkaline lactates have an opposite effect. It is not readily oxidised, but a portion is converted into water and carbonic acid, especially if administered in the form of an alkaline lactate, such as lactate of soda as it exists in soured milk.

PHYSIOLOGICAL ACTION.—Digestive System.—Lactic acid and lactates are commonly, if not constantly, found in normal gastric juice, and their administration in medicinal doses tends to promote appetite and digestive power. Doses of 1 dr. and upwards are liable to irritate the stomach, causing flatulence, pain, etc. Sugar, starch, and similar foods more readily give rise to lactic than to acetic acid, if fermentation occurs in presence of some fatty matter (Gubler). As a fact of some importance in nutrition, its power of freely dissolving phosphate of lime should be noted.

Circulatory System.—It is doubtful whether free lactic acid occurs in normal blood, but it certainly does so in some morbid conditions (Bartholow). It has been found in the muscle fluid and in the spleen, also in the thymus and thyroid glands, but is, as a rule, quickly changed into carbonates in the blood. Prout suggested a relation between an excess of this acid in the blood and rheumatism, and Richardson reported, as the result of a very incomplete series of observations, endocarditis after injecting it into the peritoneal cavity of dogs.

SYNERGISTS.—Vegetable acids, hydrochloric acid, salt, pepsin, etc.

ANTAGONISTS.—INCOMPATIBLES.—Alkalies: mineral salts.

THERAPEUTICAL ACTION.—External.—Diphtheria.—The marked solubility of false membrane in the acid has led to its local application in this disorder. If the exudation is within reach of a gargle, it may be used in that form, as strongly acid and as often as can be conveniently borne; otherwise it may be applied on a "mop" or in spray, in the strength of 1 part in 20

Tuberculous Ulceration.—Dr. Percy Kidd has recorded a case of this kind affecting the pharynx, diffused and very painful; cocaine having been painted on, lactic acid in 50 per cent. solution was applied, and after about fourteen applications healing occurred (*Lancet*, ii., 1892). It was not found specially useful in similar ulcerations affecting the skin, but has been largely employed in laryngeal cases. Sir Felix Semon reported several good cases where lactic acid was applied locally in addition to treatment by creasote internally; solutions of from 20 to 70 per cent. were applied two to four times a week and firmly rubbed into the affected part—cocaine having been previously used (*Lancet*, i., 1893).

Mr. Hunt points out that it is used not as antiseptic but as destructive, that a strength less than 50 per cent. is ineffective and the pure acid should be used as soon as possible (after cocaine). The larynx is not to be “worried” by frequent applications, but when the slough is cleared off, in a week or fortnight, the acid may again be rubbed in, and three or four times will often be enough to cause cicatrisation (*B. M. J.*, September, 1901). Dr. Baron corroborates this, but others prefer to begin with a weaker solution (*ib.*).

Catarrhal Cystitis.—Sir William Roberts, finding lactic fermentation in the bladder of a glycosuric patient aged eighty-four, with maintenance of acid non-phosphatic urine, although the catheter was in daily use, suggested that to produce an artificial lactic acid fermentation in the bladder would be a good remedy for intractable cystitis with ammoniacal decomposition and recurrent phosphatic formation; this could be done by injecting an ounce or so of a weak malt solution several times daily (*Lancet*, i., 1893). Lactic acid has also been given by the mouth in the latter condition and in oxaluria.

THERAPEUTICAL ACTION. — *Internal.* — **Dyspepsia.** — Magendie was the first to recommend lactic acid in dyspepsia dependent on deficiency of gastric juice, and Dr. Connor went so far as to say that it was more active than pepsin. Pétrequin also reported the best results from the acid and from lactates. It is now recognised as a good remedy for atonic and irritative dyspepsia, especially in combination with pepsin, but is not in very frequent use. In the aepsia of infants, with undigested food in the motions, Bartholow says this combination is excellent, but is much acidity be present the acid should be omitted or perhaps

may be given before the milk and so lessen the acidity. Cases of cardialgia in adults are relieved by the same plan.

Gubler remarks that the acid soups of Poland and the North are useful in this manner—also the whey cure to some extent.

Diarrhœa.—M. Hayem has recommended lactic acid in this complaint and especially in the “green diarrhœa” of infants, on the hypothesis of its being fatal to microbes—he gives 1 dr. doses of a 2 per cent. solution (Lancet, i. and ii., 1887).

Others have since used it in suitable doses in the diarrhœa of phthisis, typhoid, and acute and chronic catarrh, and even dysentery with good and sometimes striking results (Pract., 1889; Lancet, ii., 1892; B. M. J., i., 1892-93).

Diabetes.—Cantani suggested that lactic acid would prevent waste of tissue in this disease, and it may be presumed “to lessen the formation of sugar from starchy and other elements of food.” Certainly some cases have improved under the use of 2-4 dr. taken well diluted during the day, but cases by Dr. Ogle and others show a contrary result. It has been credited with causing rheumatism in a few cases treated by it, but this has not been corroborated by further experience. Certainly the strontium salt (lactate) has been found valuable in both rheumatism and gout.

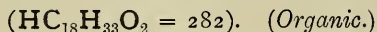
Albuminuria.—The same compound has also obtained special repute in nephritis of the parenchymatous rather than the interstitial (granular) form (Laborde, C. Paul and others, 1891-94), and my own experience supports to some extent their observations. I have found the discharge of albumin lessened in several acute and chronic cases of the former type—not so in the latter. It generally acts as a diuretic (B. M. J., ii., 1896-97—Ep.). It has not yet come into general use, and is not even mentioned by the late Dr. Dickinson (Albutt's System, 1897).

In **Epilepsy**, the lactate of zinc is used,—mostly in France.

PREPARATIONS AND DOSE.—*Acidum lacticum* (75 per cent. of hydrogen lactate): dose, 5 to 20 min., well diluted. *Strontii lactas* (not off.): dose, 5 to 30 gr. *Zinci lactas* (not off.): dose, 3 to 30 gr. For other lactates v. p. 344.

ADULTERATIONS.—The quality of the acid is often inferior.

ACIDUM OLEICUM—OLEIC ACID



CHARACTERS AND TESTS.—It is an oily straw-coloured liquid, nearly odourless and tasteless, with a faintly acid reaction; when exposed to the air it becomes brown, rancid and strongly acid. Its specific gravity varies from 0.86 to 0.89. It is insoluble in water, but readily soluble in alcohol, chloroform and ether. Equal volumes of the acid and of alcohol, heated to 77° F., should give a clear solution with free drops of oil on the surface. At 41° to 42° it becomes semi-solid, melting again at 56° to 60°. It is completely saponified when warmed with carbonate of potassium.

Use.—Oleic acid is used for the preparation of the oleates, which were presumed to have more penetrating power than ointments, but lanolin has largely superseded them.

Compounds.—**Hydrargyri Oleas**—Oleate of mercury.

PREPARATION.—Unguentum Hydrargyri Oleatis.

CHARACTERS.—A light brown, oleaginous, semi-solid substance; if gently warmed, no black precipitate settles. When heated with a piece of copper foil, the latter becomes coated with a film of metallic mercury.

Zinci Oleas—Oleate of zinc.

PREPARATION.—Unguentum Zinci Oleatis.

Oleic acid, as a solvent for alkaloids, was introduced by Professor Attfield in 1862, and later, Mr. John Marshall specially recommended oleates of mercury and morphine. Dr. Shoemaker in conjunction with Dr. Wolff experimented as to the best method of making neutral oleates, *i.e.*, true chemical compounds without excess of acid or base (the older oleates were simple mixtures, and unstable, because they were not neutral), and adopted the plan of double decomposition from sodium oleate, which is an almost colourless substance readily soluble in warm water, not so readily in cold water.

PHYSIOLOGICAL ACTION.—The oleates of quinine, strychnine, and aconitine, also of mercury, copper, and zinc, were rubbed into the skin of the abdomen in rabbits. In no case was there any constitutional effect, nor were any of the bases found in the urine. From this Dr. Shoemaker concludes, contrary to what is generally stated, that the oleates are not readily absorbed; that they do not penetrate deeper than the cutaneous follicles and

glands ; that they do not get into the circulation ; that they are chiefly local agents ; and to this latter fact he traces many of their excellent effects.

THERAPEUTICAL ACTION.—*Oleatum Aluminii* may be made into an ointment with an equal amount of lard. It coagulates the albumin of the parts to which it is applied, constricts the bloodvessels, and is useful in chilblains and burns, and in the muco-purulent discharges of eczema and dermatitis ; it also checks hyperidrosis.

With oleate of arsenic nine times the quantity of lard should be used. It has no effect on the unbroken skin, but on granulating surfaces it acts as an escharotic, and as such is useful in lupus, and chronic tuberculous ulcers.

Oleate of bismuth is emollient and slightly astringent, and is useful in pustular eruptions, such as acne, sycosis, and also in cases of cracked and sore nipples. It should be lightly pencilled over the parts affected.

Oleate of cadmium is caustic, and is but little used, though it is sometimes of value in cases of scrofulous glands.

Oleate of copper is made into an ointment with five or ten times its weight of lard. It has no effect on the unbroken skin, but on denuded or delicate surfaces it acts as an antiseptic, astringent, and stimulant, being liable to cause inflammation and pain. Its chief use is as an antiseptic and parasiticide, *e.g.*, in ringworm.

Oleate of iron, applied externally, is a valuable styptic and astringent. It is useful, when diluted, in inflamed and pustular eczema, as well as for sinuses and furuncles.

Oleate of lead has the usual effects of lead ointments, being astringent and sedative. Diluted with an equal part of simple ointment it is useful in the different forms of acne, and in eczema, especially in fissured forms, and in children.

Oleate of mercury is resolvent, alterative, and anti-parasitic ; in suitable strength it subdues inflammatory conditions, but even 10 per cent. may irritate. It is better than other mercurial ointments, because it does not get rancid, is economical and cleanly, and is absorbed so slowly that toxic effects from its use are rare. The strength should be 5 to 10 per cent. (liquid) or 20 per cent. (unctuous) ; this may be used for chronic ringworm.

The mercurous oleate is stronger than the mercuric salt, containing $1\frac{1}{2}$ times as much mercury: more mercury is therefore absorbed, and it may be used for inunction in syphilis.

Oleate of nickel (*not official*) is very like that of cadmium, being astringent and almost caustic. It is useful as an application to exuberant granulations and to old callous ulcers.

Oleate of silver (*not official*) combines with albuminous substances, and forms a protective coating when applied to raw surfaces; it also causes contraction of bloodvessels. Sprinkled over bed-sores and ulcers, it sets up healthy action, and in superficial lupus, in eczema, especially if associated with itching, and in the early stage of boils it is a most useful, and, at the same time, a painless astringent. Dissolved in oleic acid and mixed with lard, 5 to 60 gr. in the oz., it forms a dark-brown pliable ointment.

Zinc oleate is astringent and stimulating, and is especially useful in hyperidrosis; it also checks the night-sweats of phthisis. For eczema, in the weeping stage, applied either as a dusting powder or as an ointment, it is one of our most trustworthy remedies, but the *stearate* is, by some, considered better.

None of the above are official except the zinc mercury.

ACIDUM PHOSPHORICUM—PHOSPHORIC ACID ($\text{H}_3\text{PO}_4 = 98$).

This acid is widely diffused, being found free or combined with alkaline and earthy bases as phosphates in soils, and in many vegetables and fruits, such as wheat, potatoes, rice, lemons, etc., also in fish, and in the bones, nerves and flesh of animals, and in the urine and other secretions.

There are two preparations, *acidum phosphoricum concentratum*, a liquid containing 66.3 per cent. of hydrogen orthophosphate, and *acidum phosphoricum dilutum*, containing 13.8 per cent., prepared by diluting the former with water till the sp. gr. is 1.08.

CHARACTERS AND TESTS.—The concentrated acid is a syrupy, colourless, inodorous liquid, of acid, not unpleasant taste, not corrosive, and not coagulating albumin. It gives with ammonio-nitrate of silver a canary-yellow precipitate of phosphate of silver. All soluble phosphates give a white crystalline precipitate with sulphate of magnesia, after the addition of sal-

ammoniac and liquor ammoniæ (ammonio-magnesian phosphate, or "triple phosphate"— MgNH_4PO_4).

ABSORPTION AND ELIMINATION.—Phosphoric acid is readily absorbed by the stomach. Ordinary doses combine with alkalis—potash or soda—probably displacing them from combination with weaker acids, lactic or carbonic, and forming phosphates; after larger or poisonous doses, Hoffmann states that he has found it free in the blood or loosely combined with albumin (Journ. de Chim., 1868).

As phosphate it is mainly eliminated in the urine, and Böcker found the excretion of potassium phosphate especially increased under its use: some acid may possibly be eliminated in a free state.

PHYSIOLOGICAL ACTION.—The action of phosphoric bears a general resemblance to that of sulphuric acid, but in medicinal doses it is less liable to irritate the stomach or interfere with digestion, and it exerts a more stimulating effect on the general system: it has a more pleasant taste than the other inorganic acids. The pharmacopœial solution does not coagulate albuminous tissues, and, like oxalic and tartaric acid, only coagulates egg-albumin after addition of sodium chloride or other neutral salt.

Circulatory System.—The effect of moderate doses of phosphoric acid is stimulant, but of large doses, especially when injected into the blood-current, depressant. Two c.c. of a 4 per cent. solution given to a frog increased the frequency of the pulse, and the direct application of the acid to the frog's heart at first strengthened, though it afterwards weakened, the contractions; after death, the heart-muscle was non-excitable (Munk and Leyden). In warm-blooded animals, after the subcutaneous injection of about 8 grammes, slowness, weakness, and irregularity of the heart's beat occurred, with retarded respiration, lowered temperature, prostration and death (Meyer).

After injections of phosphoric acid into the jugular vein, the blood-pressure and the frequency of the pulse are lowered, although after small quantities they quickly rise again. Dr. Pavy found that he could inject 8 or 10 dr. of the dilute pharmacopœial solution into the jugular vein of a dog without causing death, and if, in any animal, the maximum amount compatible with life was injected, the urine and the arterial blood became highly charged with sugar

(Guy's Hosp. Rep., 1861). We may connect this result with the fact that phosphoric acid acts even more powerfully than hydrochloric in diminishing the alkalinity of the blood (Walter), whilst, on the other hand, injections of soda prevent the production of artificial diabetes; but the full bearing of such facts is not yet known. Injections of acid into the carotid artery caused primary slowing of pulse with secondary quickening before death, strong inspiratory cramp, convulsions and coma (quoted by Husemann). After death from excessive quantities, ecchymoses were almost always found in the lungs, and the blood was altered, being dark but fluid, and not easily coagulable, sometimes gelatinous. The effect on the blood is not always the same: thus Dr. Pavy, in one experiment, found the "large venous trunks in the liver plugged with coagulated blood," after an injection of 30 dr. of acid into the duodenum; and Gubler says, "Introduced into the veins of animals, phosphoric acid coagulates the blood and causes death in a few minutes": this depends on the dose and concentration. Neumann states that the corpuscles are not destroyed by the acid, but may be much altered in form and vital properties.

The action upon man is of more practical interest; Bobrick records a rise of the pulse from 70 to 90 beats per minute, but in the course of an hour it fell to 66; this was after a dose of $\frac{1}{2}$ oz. A rigor also occurred, followed by a sensation of warmth. Dr. J. B. Andrews (N.Y.) administered doses of from 1 to 3 dr., and investigated the effect by means of sphygmographic tracings taken at intervals of from fifteen minutes to one hour. He says: "Within the first interval there is an increase in the force of the pulsations, though there is little change in the number during the whole time of experimentation. The increase is most marked after the lapse of from one to two hours, and it is not till after several hours that the pulse returns to its normal condition. The first experiment I made upon myself, beginning with 20 drops, and continuing the use of the remedy in increased doses till the amount of 4 dr. was reached. The sensations experienced from 40 min. to 3 dr. were those of moderate alcoholic stimulation, slight pain through the frontal region, and a buoyancy and lightness of feeling rather agreeable. . . . In the pulse-traces, additional force is manifest in the heart's action in all cases, and in the general appearance of weakly persons placed on acid treat-

ment the same fact is apparent—the congestion of the extremities and lips has soon given place to a more natural colour” (Amer. Journ. of Insan., 1869).

Nervous System.—The same observer and others find phosphoric acid to be a powerful nerve-tonic, but the conclusions are founded more upon clinical observations on depressed persons than on the healthy. “Moderate doses produced on the latter the feeling of buoyancy and exhilaration already mentioned, but larger quantities caused a feeling of drowsiness, an inclination to lie down, and unwillingness for mental labour.” The acid exerts also a marked control over the vaso-motor nerves, and through them improves the tone of the circulation. Hecker and Burdach concluded that phosphoric acid acts more than any other on the nervous system, heightening excitability in a great degree. Sundelin asserted that this action is directed especially to the genital organs, and although neither Neligan nor Andrews could verify this, I have myself noted it in sixteen patients, who had no knowledge of the supposed aphrodisiac quality of the drug; they all complained to me of such effects in greater or less degree.

Digestive System.—Moderate doses improve the tone and functional power of the stomach, and, as already remarked, this acid irritates much less, even after continued use, than the other inorganic acids; large or concentrated doses, however, taken by the mouth, may cause gastro-enteritis, and redness, erosion, and ecchymoses have been found, after death, in the stomach and duodenum (Munk and Leyden). When Dr. Pavy injected 1 to 2 oz. into the stomach of dogs it was quickly rejected, but on introducing it into the duodenum, a saccharine condition of the urine and the blood was produced, just as after intravenous injections. After toxic doses, fatty degeneration has been found in the liver, kidneys, and muscular tissue.

SYNERGISTS AND ANTAGONISTS.—The same as for other inorganic acids. Vegetable bitters might be included in the former.

THERAPEUTICAL ACTION.—*Internal.*—**Nervous Debility.**—Phosphoric acid in the treatment of nervous debility acts much like iron in anæmia, as a chemical food supplying something deficient in the nutrition of the nervous system. When mental effort has been protracted till a sense of weariness renders its

continuance difficult, a dose of the acid, from its stimulant effect, relieves fatigue, and seems to invigorate the mental powers, and prepare the mind for renewed exertion (Dr. J. B. Andrews). It relieves peripheral congestions connected with impaired tone of vaso-motor nerves, and in weakened relaxed conditions akin to impotence, and resulting from sexual excess, it has proved a special help.

In **Anæmia**, and in the exhaustion of prolonged lactation, Shoemaker recommends it.

Fever.—In any fever where the nervous system is specially depressed, phosphoric acid is indicated; it assuages thirst, and helps to remove exhaustion; its pleasant taste is one advantage over the other mineral acids. Stromeyer and others recommend it in “eruptive fevers.” The following is a convenient form: R Acidi phosphorici diluti, fl. ʒ ii j; glycerini, fl. ʒ j; decocti hordei, O ij; mix, and use when cold as a drink.

Diabetes.—Phosphoric acid often relieves the thirst of this malady, and has been recommended by Latham, Watson, and other physicians; on the other hand, the experiments of Dr. Pavy (already quoted) indicate that much of it would be injurious, and Griesinger not only states that it does not lessen the excretion of sugar, but in one case supposes it actually to have caused the malady. Against this, we might set a case recorded by Thornley, in which the thirst was relieved and the patient apparently cured (Med. Press, 1868); but without being in a position to dogmatise on the matter, I may say that I have seen on several occasions the symptoms relieved and the amount of sugar in the urine diminished during its administration.

Urinary Disorders.—In phosphatic deposits connected with waste of nervous tissue, and in alkalinity of urine with nervous depression, phosphoric acid is very useful, and it has relieved the symptoms of phosphatic calculus and urethro-vesical catarrh, when nitric and hydrochloric acids had failed; benefit has also been derived from it in *oxaluria*.

In **Rachitis**, the milky phosphatic condition of the urine is cleared by the acid, though Dr. H. Wood considers that the phosphates act better. It also relieves the diarrhœa and sweating.

Phthisis.—In this condition generally, phosphoric acid fulfils many indications as a grateful, moderately astringent tonic; it

relieves hoarseness and dry irritating cough accompanied by pain and laryngeal soreness.

In the *dyspepsia* so common in phthisis, it is also useful, relieving the pain, sickness, and diarrhœa which occur after meals. Profuse night-sweats and other exhausting discharges, such as occur in the bronchial catarrh of weakly subjects, are controlled by it.

Hæmoptysis.—Hæmorrhage.—M. Hoffmann recommends this acid in hæmoptysis; and the main reasons for his preference of it would seem to be its “less corrosive action,” and better toleration by the stomach, otherwise its stimulant powers would make it less generally suitable than sulphuric acid; he gives 10 to 30 drops in mucilage (*Journ. de Chim. Méd.*, 1868). I have seen good results from the acid in purpura and passive hæmorrhage, also in metrorrhagia.

Strumous Conjunctivitis.—This malady is often troublesome, not so much from its severity as from its persistence and great tendency to relapse, and Mr. Balman has written to praise phosphoric acid, not only in struma, but specially “in the intermittent ophthalmia of a scrofulous constitution”: he says that, given in doses of from 5 to 20 min. in calumba, the acid both cures and prevents recurrence of the affection (*London Med. Gaz.*, 1858).

Scorbutus.—Liebig and others have held that the scurvy of sailors is mainly owing to the exclusion of phosphoric acid from their diet, since in the ordinary preparation of meat for sea-stores the greater portion of the acid is extracted from it, and the complaint has been cured by giving food containing the acid, although the sailors continued to use the salted beef to which scurvy was attributed (*Letters on Chemistry*). Professor Galloway has verified the presence of phosphoric acid in lemon-juice, and hence, according to Morgan and Neligan, its superiority to citric or tartaric acids, but I am not aware that the theory has been largely tested in practice.

Diarrhœa.—Phosphoric acid is suitable for cases of diarrhœa when an acid is indicated. Sedgwick strongly recommends it for choleraic cases, and argues for its use in true cholera (*Lancet*, ii., 1871). In ordinary conditions, however, its action is said to be rather laxative than astringent.

PREPARATIONS AND DOSE.—*Acidum phosphoricum concentratum*: dose, 1 to 4 min. (seldom used). *Acidum phosphoricum dilutum*: dose, 5 to 20 min., freely diluted. Phosphoric acid is also contained in *syrupus ferri phosphatis* and given with iron preparations renders them compatible with astringent vegetable infusions (Martindale). For glycerophosphates and hypophosphites v. Phosphorus.

ACIDUM SULPHURICUM—SULPHURIC ACID—OIL OF VITRIOL ($\text{H}_2\text{SO}_4 = 98$).

This occurs native in the water near volcanoes, as in Java, and in the Sour Springs near the Erie Canal. It is found in combination in twenty-two natural sulphates, also with ammonium in rain-water near towns. It contains 79 per cent. of anhydrous sulphuric acid (SO_3), and about 98 per cent. of H_2SO_4 .

There are two other forms of the same acid, the *acidum sulphuricum dilutum* and the *acidum sulphuricum aromaticum*, which are about one-eighth of the strength of the concentrated acid, the former containing 13·65, the latter 13·8 per cent. of hydrogen sulphate.

CHARACTERS AND TESTS.—The pure acid is an oily-looking, colourless liquid, but the commercial acid (which is contaminated with arsenic) is often dark-coloured from contained fragments of charred organic matter. The former is odourless and does not fume, but has an intensely acid taste and an energetic affinity for water, which it absorbs readily, so that a partially filled bottle of acid, if exposed to damp air, will, after a time, overflow; if quickly mixed with water much heat is evolved. A very small quantity of sulphuric acid, or of any soluble sulphate, can be detected by adding to the diluted solution a little chloride of barium, which gives a dense white precipitate, insoluble in acids. (Sulphuric acid prepared from pyrites often contains appreciable quantities of arsenic.)

ABSORPTION AND ELIMINATION.—Moderate doses of the dilute acid are readily absorbed, either as sulph-albuminates, or, after combining with bases in the gastro-intestinal secretions, as sulphates of potassium or sodium.

The dilute acid forms with albumin both a soluble and an insoluble compound according to the degree of dilution, the former resulting from quite weak acid. That dilute sulphuric acid may be absorbed through the *skin* follows from the experiments of

Lebküchner, who induced an acid reaction of the urine and fæces by applications to the abdomen of rabbits.

Gubler teaches that this, like the other mineral acids, circulates in the blood but loosely combined with albumin, and that on reaching the emunctories the combination breaks up, albumin remaining in the vessels, whilst the acid passes out with the excretions combining with the bases therein found.

It is a question whether, after poisonous doses, the acid may be absorbed and remain free in the blood, leading to coagulation of the latter. Geoghegan states that after the ingestion of $1\frac{1}{2}$ oz., when a woman survived thirty-one hours, he found traces of acid in the pericardium and in the kidney, not in the blood, but in that fluid he found much *phosphoric* acid, derived, he suggested, from phosphate of sodium, from which sulphuric acid had displaced it. In another case Dr. Walker found a trace in the cerebro-spinal fluid and in the cardiac blood. Casper stated that he had found the blood and serous fluids acid, and Carus reported sulphuric acid present in all the organs of a foetus, after a fatal dose taken by the mother (Beck's Jurisprudence, ii.). More recent researches indicate that mineral acids cannot be detected free in the blood, and that its reaction cannot be rendered acid consistently with life. It is not likely that the coagula described by Bouchardat in the great vessels were really due to direct action of free acid,—Taylor could find no trace of it in similar coagula (On Poisons). It is, however, possible that the blood may be found acid after death.

The acid is eliminated by the urine, and, according to Dr. Letheby, very quickly after full doses. Most observers agree that it cannot be found free in that secretion, but as sulphate; and the heightened activity is really due to uric and lactic acids displaced by the stronger sulphuric acid from their ordinary combinations. Seeing the comparatively small amount of sulphuric acid accounted for in the renal secretion, Headland suggested that some passed by the lower bowel and the skin, and this is probable.

PHYSIOLOGICAL ACTION.—*External.*—The dilute acid applied to the skin causes burning pain and pallor, followed by redness; more concentrated, it destroys the epithelium, changing it into a firm brown mass. It coagulates albumin, and disintegrates horny tissues with formation of leucin and tyrosin. In its full strength, it causes destruction and sloughing of any tissue by

virtue of its strong affinity for organic bases, as well as for the water with which they are combined. It has been not infrequently used in revenge—thrown on the face; in such cases, an alkaline wash should be applied before the ordinary treatment of burns. The acid has disinfectant and antiseptic powers and destroys infusorial life.

PHYSIOLOGICAL ACTION. — *Internal.* — **Digestive System.**—Very small doses give a characteristic acid taste, and lessen the sensation of thirst; 10 to 15 min. of the dilute acid, administered several times at intervals, stimulate the appetite and exert an astringent effect on the gastric and other secretions. If continued, however, the medicine induces dyspepsia with acid eructation, colic, and diarrhoea, which may be due to the large amount of alkaline sulphates formed, as well as to direct irritation.

The local symptoms induced by *toxic* doses of the strong acid are very severe; intensely acid taste is followed by burning pain in the mouth, pharynx, and stomach, and violent retching with vomiting, the ejecta usually containing dark blood; there is extreme thirst and sense of distress—sometimes purging with tenesmus. The faucial inflammation may induce suffocation, angina, or laryngeal cedema, and thus prove fatal early in the case; or peritonitis may be set up, and if death do not occur from collapse, it may follow on perforation of the œsophagus, stomach, or bowel in twelve to forty-eight hours after the poisonous dose; should life be saved for the time, the inflammation of the alimentary tract is likely to be followed by serious contraction, or the loss of gland tissue from destruction of the mucous membrane will produce a permanent dyspeptic condition; swellings, and suppuration of the parotid glands may occur; any slough produced is black in colour.

Circulatory System.—Bobrick found, with frogs, that sulphuric acid, given by the stomach, or applied to the skin, caused the heart to act more slowly, and finally stopped it in diastole. Hertwig, experimenting on mammalia, found that moderate doses of the dilute acid lowered the pulse-rate and the temperature, whilst arterial tension was increased. It has been said by some that the blood becomes less, by others more coagulable, but its exact state is not ascertained; nor do we rightly know whether the smaller vessels are contracted or not by the acid. When injected into the veins it causes instant death from coagulation of

the blood, and the corpuscles are altered or destroyed by toxic doses taken internally.

In cases of poisoning, the disturbance of circulation is mainly secondary to the gastric irritation: there may be syncope or collapse, the pulse becoming later rapid and small, the extremities icy cold, and respiration laboured and superficial.

Glandular System.—Most of the secretions become more acid under this drug, and some of them, especially those of the skin and the bowel, are lessened in amount. Bobrick, however, found the quantity of urine and the amount of urinary sulphates increased by it. After large doses, Leyden and Munk distinguished different conditions corresponding to different alterations in the kidney; finding albumin alone, or with epithelial casts, or with fatty globules and epithelium, or in addition, hyaline casts, blood, and leucocytes (nephritis)—Huppert (1898) found hæmaturia.

Pathological Changes.—Besides the inflammation and contraction mentioned, fatty degeneration of different organs has been described as a constant result of poisoning by sulphuric acid, and particularly in the liver, the striped muscular tissue, the heart, and the renal epithelium. Such change may be explained by the destructive action on red corpuscles, which are in part destroyed, and in part altered, becoming smaller, darker, and of granular appearance; hence also the lowered temperature, feeble pulse, and general debility, as well as the functional albuminuria from excretion of constituents of the altered blood-cells.

SYNERGISTS.—The other acids and cooling remedies are allied in action, and as regards styptic effects, ergot and astringents generally are auxiliaries.

ANTAGONISTS.—INCOMPATIBLES.—Warm stimulating remedies antagonise some of the effects of sulphuric acid. Alkalies and bases are chemically incompatible. The best antidotes in a case of poisoning are magnesia, chalk or white-wash, and soap, which should be given in albuminous solutions, such as milk and water. Alkaline carbonates are not advisable, they form irritant compounds; they also evolve much carbonic acid, but may be used in cases of emergency. Oil to protect the mucous membrane of the stomach is useful.

THERAPEUTICAL ACTION. — *External.* — The caustic

property of strong sulphuric acid is utilised comparatively seldom, on account of the difficulty of restraining it within due limits.

Chancre.—Gangrene.—Cancer.—In chancre, with phagedænic ulceration, Ricord recommended a caustic paste made with sulphuric acid and charcoal, to be applied on linen for several hours—until a slough formed : the pain, however, is very great. In hospital gangrene the pure acid has been successfully employed ; for such purposes and for cancer, Sir J. Simpson mixed it with zinc sulphate. The reason for using powders, especially charcoal, to mix with the acid, is to secure a full strength in convenient form without dilution with water : Syme employed sawdust, Velpeau, saffron.

Caries.—Necrosis.—It is evident that a lotion containing mineral acid will dissolve out the earthy bases of bony tissue, and for this purpose in the past it has been applied to some extent in surgery. Chassaignac recommended dilute hydrochloric acid, and Mr. Pollock brought forward much evidence in favour of the application of sulphuric acid mixed with an equal part of water, “ for the more speedy removal of dying bone, or more rapid separation of dead portions, or destruction of the surface of carious cavities ” ; he found it simple, safe, and comparatively painless, nor had he ever seen bad consequences from it, but surgical measures are generally preferred.

Poisoned Wounds.—Sulphuric, like other mineral acids, when employed to cauterise poisoned wounds, bites, etc., has the advantage over solid caustic of more *penetrating* power. Dr. W. Frazer considered strong sulphuric acid better than any other.

Parasitic Skin Diseases.—In ringworm and in scabies, an ointment containing 1 dr. of acid to the oz. of lard has sometimes proved useful (though irritating) ; for the latter malady it is largely used in the Prussian army.

Pruritus.—In prurigo, lichen, and chronic urticaria, disorders attended with violent itching, a lotion containing 1 to 3 dr. of dilute acid in 8 oz. of water often relieves. Pereira says that its internal administration is also efficacious.

Sore Throat.—For relaxed surfaces coated with tenacious mucus dilute sulphuric acid is an excellent cleansing astringent : hence it is in constant use as a *gargle* (1 to 2 dr. in 8 oz. of infusion of roses) for relaxed uvula, etc. ; in weaker proportion it is

also suitable for scarlatinal throat. The addition of 2 dr. of alum with glycerin or syrup to the gargle greatly increases its value.

THERAPEUTICAL ACTION.—*Internal.*—It is commonly said that for digestive disorders requiring an acid, hydrochloric is the best: to stimulate hepatic and intestinal secretion nitric acid is indicated, whilst the astringent effect of sulphuric is of special value in controlling sanguineous and other discharges.

Hæmorrhage.—Sulphuric acid was formerly in frequent use as an internal remedy for hæmorrhage, especially of passive character, whether from the stomach, lungs, or uterus. That there is difficulty in explaining how it can exercise astringent effect after dilution and possibly combination in the blood, would be no argument against its use if this were *proved* efficacious; but my experience is the same as that of many modern observers (amongst whom I may mention Nothnagel and H. C. Wood), who give to sulphuric acid a secondary place amongst hæmostatics, although it will succeed *sometimes* when other remedies fail.

Diarrhœa.—Dilute sulphuric acid has a well-deserved reputation in various forms of intestinal flux, and especially in summer diarrhœa of choleraic character: it often answers well, but when given alone I have sometimes found it aggravate the disorder, perhaps by irritation or by increasing the acidity of secretions: the aromatic sulphuric acid should then be preferred in combination with some preparation of opium: *e.g.*, R \bar{x} Acidi sulphurici aromatici, \bar{z} iss; Tincturæ Opii, \bar{z} i; Tincturæ Cardamomi Co., \bar{z} i; Spiritus Chloroformi, \bar{z} iss; Aquam ad., \bar{z} vi; one or two tablespoonfuls to be taken three times a day or oftener if necessary.

In diarrhœa, with coated tongue and evidence of biliary disorder, the acid acts well with small doses of magnesium sulphate, tincture of rhubarb, and chloroform water; it is a good remedy for children.

Fever.—In the diarrhœa of enteric fever, H. Kennedy, Murchison and other authorities have advocated the use of sulphuric acid. We do not expect from it the power of shortening the morbid process; but it will allay thirst, and, to some extent, moderate the pyrexia and the undue secretion. In enteric cases the dose used should be small and well diluted: the aromatic I find preferable to the simple form.

Pyrexia.—**Phthisis.**—The acid certainly is of more service

in secondary pyrexial states than in specific fevers. In subacute inflammatory conditions of protracted character occurring, *e.g.*, during caseous pneumonia or chronic phthisis, it alleviates the general symptoms, and sometimes the local conditions. It is well suited for phthisical cases with a tendency to undue discharges, for it acts as a tonic and astringent, lessening the night-perspirations, the intestinal flux, and the expectoration: by combining it with opium, belladonna and aromatics, so much relief may be sometimes given as to merit for the remedy its old title of "Elixir Vitriol" (when mixed with alcohol).

The presence of cough does not contraindicate its use, but irritation of the fauces must be obviated by mucilage or syrup: and acids must be omitted if they set up gastric irritation.

Lead Poisoning.—Since the publication of the cases of M. Gendrin and Dr. H. Bennett in 1846, the acid has had more or less reputation as an antidote and prophylactic in poisoning by lead; but later observation does not corroborate their estimate of it. Tanquerel especially failed to obtain good results; on the contrary, the use of an acid lemonade seemed to make the workmen more liable to colic. In white lead works, however, it is still sometimes used and is made with sulphate of magnesia, sulphuric acid and fresh lemons; it is presumed to change lead carbonate into sulphate, which being insoluble is passed out with the fæces. To some extent this is true, but even the sulphate is more or less soluble in the intestinal juices, and proportionately toxic (T. Oliver). A better preventive is sulphur in milk, which forms an insoluble sulphide.

PREPARATIONS AND DOSE.—*Acidum sulphuricum*—*Oil of vitriol*: is not used internally. *Acidum sulphuricum aromaticum*: dose, 5 to 20 min. freely diluted. *Acidum sulphuricum dilutum*: dose, 5 to 20 min. freely diluted. An alkaline mouth-wash should be used after taking the acid. The aromatic acid is contained in *Infusum cinchonæ acidum*, and the dilute acid in *Infusum rosæ acidum*. It is said to favour the growth of mould in medicines (Binz).

ADULTERATIONS.—The usual impurities of this acid are salts, nitrous oxides, arsenic, and lead.

ACIDUM SULPHUROSUM—SULPHUROUS ACID ($\text{H}_2\text{SO}_3 = 81$).

CHARACTERS AND TESTS.—This is an aqueous solution of sulphurous anhydride, SO_2 , colourless, of strong suffocating odour and pungent acid taste, which, however, is not unpleasant in moderate dilution. Its sp. gr. is 1.025. It bleaches vegetable colours, and is an energetic oxidising agent: it is said to absorb radiant heat in a high degree. The hydrated acid can be obtained in crystals, but is very unstable. A solution of the official strength and upwards oxidises on exposure to light and air (*e.g.*, when kept in partially filled transparent bottles), with formation of sulphuric acid—an important change, since the special properties of the drug are thereby impaired or lost; contact with chlorine at once induces this change ($\text{SO}_2 + 2\text{H}_2\text{O} + 2\text{Cl} = \text{H}_2\text{SO}_4 + 2\text{HCl}$). It should therefore be carefully kept; or, better still, be freshly prepared when wanted.

1. When evaporated, it should leave no residue. 2. Barium chloride should give no precipitate, or only a very slight one. It is rare to find a solution which contains no sulphuric acid, and this it is which is precipitated by the barium chloride. 3. Sulphurous acid decolorises a solution of iodine.

Sodii Sulphis—*Sulphite of Sodium* ($\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$).—Occurs in white efflorescent prisms which have a slightly alkaline or neutral reaction, and the odour and taste of sulphurous acid; it is soluble in cold water (1 part in 4), and in less than 1 part of boiling water; also very soluble in spirit.

Sodii Hyposulphis—*Hyposulphite of Sodium* ($\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$) (*Appendix B.P.*).—Occurs in colourless crystals (oblique rhombic prisms), and is bitter, slightly alkaline, and sulphurous in taste, less unpleasant than the sulphite. It is very soluble in water, but not in alcohol, decolorises iodine solutions, and dissolves salts of silver which are commonly insoluble, *e.g.*, the chloride. A solution of hyposulphite is distinguished from one of sulphite by the precipitation of sulphur on adding sulphuric acid. Hyposulphites do not act on potassium iodide.

Potassii Sulphis—*Sulphite of Potassium* (*not off.*).—Occurs in white opaque fragments or powder, with a slight odour of the gas—very soluble in water (1 in 3). Its taste is saline and sulphurous.

Magnesii Sulphis—*Sulphite of Magnesium* (*not off.*).—Contains proportionately more of the acid than the other salts; it is also the most soluble, and the least unpleasant.

Calcii Sulphis—*Sulphite of Calcium* (not off.).—It is soluble in only 800 parts water, but the bisulphite and hyposulphite are freely soluble.

ABSORPTION AND ELIMINATION.—*Sulphurous acid* is readily absorbed, and its characteristic odour has been observed in the breath and secretions after its administration. It passes out also with the urine and fæces as sulphate, for it is readily oxidised in the system.

The *sulphites* are decomposed in the stomach by the gastric acid, sulphurous acid being given off; they are mostly changed into sulphates and are eliminated as such, partly by the intestinal canal, but chiefly by the kidneys; they pass within twelve to twenty-four hours after administration. The *hyposulphites* undergo similar changes, but more slowly, for they are more stable.

After very large doses, these salts may be found unchanged in the urine (Rabuteau), and after their application to wounds, free sulphuric acid may be traced in the same secretion.

PHYSIOLOGICAL ACTION.—*External.*—Externally applied, sulphurous acid is refrigerant, somewhat astringent, and in full strength irritant. The most important property of the gas and its compounds is that of arresting fermentation, and of destroying the lower forms of vegetable and animal life, and certain infective organic poisons. Its power of controlling fermentations and destroying visible parasites is readily proved.

For aerial disinfection Hoppe-Seyler, after careful trial, found sulphurous acid gas the best agent—1 or 2 per cent. of it in the air of a room destroying all the lower organisms: this could be secured by burning $\frac{1}{2}$ to 1 dr. of sulphur for each 100 cubic feet of space (Lancet, ii., 1871). Letheby arrived at similar conclusions, but recommended, for greater security, a larger proportion of sulphur— $1\frac{1}{2}$ oz.—to each 100 cubic feet of air.

Of the gas, 1 part in 100,000 of air is perceptible to the sense of smell; 9 parts are disagreeable and provoke cough; 20 parts are irritating, and 43 parts (= 4 parts in 10,000) are irrespirable: much less than this will kill plants (Letheby). In generating it by burning sulphur in air, 32 parts by weight, in round numbers, combine with an equal quantity of oxygen to produce 64 parts of sulphurous anhydride, which occupy the same bulk as the oxygen employed. Its density is high, the sp. gr.

as compared with air being 2·247; a cubic foot weighs about 1,206 gr., and to produce it 603 gr. of sulphur and a cubic foot of oxygen (= 5 cubic feet of atmospheric air) are requisite.

Baxter concluded not only that sulphurous acid was the best of aerial disinfectants, but that its action on vaccine virus was more potent than that of chlorine or carbolic acid. (Sixth Report of Med. Off. Privy Council, N. S., and Lancet, i., 1876.) Dougall had found sulphurous not so effective as other mineral acids (notably chromic) in preventing the decomposition of organic solutions, but Grace Calvert showed this was not correct, and 1 part of the former in 1,000 of albuminous solution was enough to preserve it for forty days, whilst other acids only preserved it for nine or ten days. Dr. Fergus also compared glasses of beef extract heated with sulphurous acid, carbolic acid, and terebene, and found several weeks afterwards that the one heated with sulphurous acid remained sweet whilst the others were decomposed (Pract., i., 1877). The action of pepsin is arrested by a strength of 1 in 1,300, of ptyalin—and diastase by much less.

Dr. Wolffhügel has found that, although the gas in the dry state is able to destroy bacteria, it cannot kill the spores of these organisms; but when the gas is employed dissolved in water the germicide action is very marked, a strength of 0·75 to 0·1 per cent. being sufficient to kill the spores as well as the fully developed bacteria. These experiments are quite in keeping with the property of the dry spores to resist dry heat, while they are killed by exposure to a lower temperature if they are moistened. Anthrax bacilli are destroyed quickly by this strength, but anthrax spores resist 6 per cent. for some days. Wolffhügel considers that when using the gas obtained by burning sulphur in a room as a disinfectant, it is safer to moisten the floors, walls, fabrics, and other articles in the room with water before setting light to the sulphur. (Koch finds sulphurous acid, as well as many other disinfectants, inferior to perchloride of mercury.)

PHYSIOLOGICAL ACTION.—*Internal.*—There can be no doubt of the disinfectant power possessed by sulphurous acid when brought into *direct* contact with infective or putrescent material, whether in the air, or in wounds, etc., but the further question

whether it can be so introduced into the blood of living animals as to neutralise a septic poison therein, or so as to prevent the admission of such poison, is more difficult. Dr. Polli (Milan) held the affirmative to be proved by his experiments upon dogs with sulphites and hyposulphites; after treating an animal with these medicines, he injected septic material, and found it did not succumb to the effects, whilst a healthy but untreated animal quickly did so. In other cases, examining the bodies of animals killed after treatment with sulphites, they were found to decompose much less quickly than others not so treated. He offered, also, some clinical evidence of the value of these remedies in septicæmia, and much practical benefit was expected from his observations; they have not, however, yet passed the region of controversy. Semmola, O. Weber, and others, deny them, or characterise them as "negative."

Digestive System.—Sulphurous acid solution may be taken internally, in moderate doses and well diluted, without definite effects on the healthy body, unless it be the quenching of thirst and cooling: I have not found it interfere with peptic action, though it might do so if given with, or after food, in full doses. Insufficiently diluted, the solution excites local irritation of the digestive tract, and sometimes of the bronchial mucous membrane, some persons being more sensitive to this than others. The sulphites and hyposulphites in large doses increase peristalsis, and cause purging, though not so readily as sulphates.

Temperature.—Given during the pyrexial state, sulphurous acid is said to lower the body-temperature.

SYNERGISTS.—Disinfectants and antiseptics aid the action of sulphurous acid, but it is so readily oxidised that it is better used alone. Steam favours the antiseptic action of the gas, and nitre added to the burning sulphur makes it more effective.

ANTAGONISTS.—All oxidising substances alter the chemical constitution of sulphurous acid, and impair the peculiar properties of sulphites, especially when in solution. The mineral acids, including sulphuric, decompose sulphites and hyposulphites.

THERAPEUTICAL ACTION.—*External.*—**Parasitic Skin Disease.**—**Favus.**—**Ringworm.**—Sulphurous acid solution is a cleanly and efficient mode of treating these maladies. It may be painted on occasionally in full strength, or used in lotion or com-

press, 1 part to 2 or 4 of water and glycerin—the great point is to secure its thorough contact with the diseased surface. An American method is to burn sulphur in a closed box fitting to the head for half an hour at a time; Harrison's mode of applying nascent acid is described below under Lupus, and has been found effective.

Pityriasis Versicolor.—A weaker lotion than the last-mentioned, 1 part in 8, or one containing sulphite or hyposulphite of sodium ($\bar{5}j$ in $\bar{5}vij$), will cure this disorder. (The same lotion, or one half the strength, is useful in cases of foetid perspiration.)

Pruritus Vulvæ, etc.—When pruritus is dependent on discharge, or other source of irritation, possibly parasitic, injections and lotions containing sodium bisulphite (gr. xv ad $\bar{5}j$) have been found serviceable. The itching of lichen and of true prurigo senilis may also be relieved by lotions containing sulphites.

Erysipelas.—A sulphurous lotion will often give great relief to the burning pain of erysipelas, and its constant application is said to cut short the malady. Hewson records twenty-seven cases of various degrees of severity—seven of them idiopathic, and all treated by the local use of a sulphite lotion (sodii sulphis gr. x ad $\bar{5}j$) applied on lint covered with oiled silk; it bleaches the skin and “destroys the inflammation.” Pairman describes great and immediate relief to pain in a severe case of facial erysipelas from a lotion of equal parts of glycerin and sulphurous acid: the patient recovered at the end of a week, but tincture of steel and other remedies were given internally; relief, however, was clearly traceable to the lotion, and it deserves to be more generally used than it is at present.

Lupus.—H. Collier has recorded several cases of lupus which had been previously treated with various caustics unsuccessfully, and which were cured by the use of sulphurous acid. He applies the remedy in one of three ways. (1) As gas: this is the most effective, though rather troublesome: fumes from burning sulphur are allowed to come into contact with the ulcerated surface for about twenty minutes every day for several days. (2) As a lotion of the pharmacopœial strength of the acid, or diluted in the proportion of 1 to 2 or 1 to 4, the last strength being the most useful. (3) As an oil: he obtained the best results from applying a mixture of the concentrated alcoholic solution of the gas with

equal parts of castor or olive oil. Another method has been devised by Dr. A. J. Harrison, who applies an aqueous solution of sodium hyposulphite (gr. xl ad ʒ j) to the affected part during the night, on lint covered with oilskin, and in the morning a "day lotion" containing 5 min. of pure hydrochloric acid in the ounce of water. There may be some pain with this application, but it is not severe, and nascent sulphurous acid is developed in contact with the lupus tissue, which it disinfects and destroys; a soothing cerate or lotion may be required at intervals. He reported nine satisfactory cases of various ages and duration, and found the treatment equally effective in the common and the erythematous forms (B. M. J., ii., 1892).

Chilblains.—Corns.—Fissured Nipples, etc.—For these ailments sulphurous acid is a good remedy. Pairman applies the strong solution of the acid on lint covered with oiled silk: if the skin be broken the acid should be diluted. Sore nipples are to be "soaked well with strong acid for a few times" (Pamphlet, *The Great Sulphur Cure*, 13th ed., 1868). Fergus applies the acid in spray to chilblains, or uses as a wash 3 parts of the solution to 1 of glycerin and 1 of water.

Bruises.—Sprains.—The same surgeon found a lotion containing sulphurous acid useful in "every kind of bruise and sprain." He recommends a spray of pure acid for six or seven minutes till the part feels cold, then lotion (1 in 8) to be applied and frequently changed; in forty-eight hours inflammation and pain have subsided, and on the third or fourth day the limb can be strapped or bandaged.

Wounds.—Fractures.—Fergus records excellent results from the acid used in lotion to a severe contused wound of the face (where it is always important to avoid scarring): under a lotion of 1 part in 7 constantly applied, the wounds healed quickly and without suppuration. I can corroborate this to some extent, but the treatment has not come into general use. Dr. John Balfour has had marked success with a lotion (1 in 12) applied on *thin* rag kept constantly wet for the first day or two after injury, afterwards wetted every twelve hours with tepid lotion kept covered by oiled silk, zinc ointment being substituted about the third or fourth day. Severe compound fractures of the hand with laceration of tendons, and gunpowder burns, fractures of the shoulder and

other joints by machinery—all did well under this treatment, which seemed to give almost instant relief from pain, to control and greatly restrain suppurative action and secure primary union.

Ulceration.—Gangrene.—In cases of unhealthy open wounds and hospital gangrene, sulphurous has sometimes proved more efficacious than carbolic acid ; this was especially seen in hospitals at Metz during the Franco-Prussian War.

Sore Throat.—In various forms of sore throat, sulphurous acid as a gargle, or preferably in fine spray, is useful, relieving pain, lessening inflammation, destroying parasitic growth, and cleansing unhealthy suppurating surfaces. It is, in my experience, of great value in *aphthous* conditions such as occur during phthisis or other exhausting diseases, as well as in the ordinary form common during infancy ; it often relieves the pain, tension, and ulceration of scarlatinal and variolous throats, and I have seen it of the greatest service in chronic syphilitic ulceration of the fauces.

In the acute inflammatory stage of sore throat it is not always well borne, but will be found to answer better in such cases when used of full strength, if only for a very short time, than if diluted ; in the latter case it has seemed to irritate the mucous membrane without controlling inflammation, but there is no *one* rule, a short trial will be the best guide ; young children do not usually bear it well. Fergus, on the other hand, says it is good “in all forms of inflammation of the throat and tonsil” ; it should change the turgid redness to a light pink during the application.

Dysphonia Clericorum.—Follicular Pharyngitis.—Dewar has published cures of this condition, so rapid and after so many years' duration of the malady, as to border on the marvellous. One clergyman, a sufferer for twenty years, found immediate relief from the spray, “something loose, feeling braced up.” The cases are described in popular language rather than with scientific accuracy, but we may accept the fact of much relief having been afforded in the class of maladies referred to.

Catarrh.—Hay Fever.—A sulphurous acid spray applied to the nostrils often relieves these maladies ; sulphur-fumigation is also said to have cured them quickly.

Chronic Bronchitis.—In old times the sulphur vapour of Pozzuoli and similar places was resorted to, and the spray is sometimes a useful adjunct in the treatment of this condition ;

it acts as a stimulating expectorant, thinning the tough viscid phlegm; sulphur-fumigation is also good. It will not, however, accomplish the great benefits at one time expected from it, and should be commenced cautiously, as it excites cough.

Pertussis.—The vapour is also of much service in this disorder and may be utilised in the mode described by Dr. Mohn and Mr. Manby, the patients being removed from their bedroom whilst about 1 oz. of sulphur to every cubic metre (10 gr. to every cubic foot) is burnt in the room for about five hours and then the windows and doors opened: any clothing, etc., is exposed at the same time, and afterwards the patients are brought back to sleep in the disinfected room. "Cough is lessened in frequency, expectoration rendered easier, paroxysms have been less violent, and sickness has ceased in twenty or more cases" (Pract., 1887-88). My own experience is also favourable with this treatment.

Phthisis.—Dewar has recorded a remarkable case in the person of a groom advanced in phthisis, with emaciation, cough, sweatings, hæmoptysis, etc., and apparently in a hopeless condition, who conducted sulphur-fumigations for cattle (*v. p.* 373), remaining with them in the sheds "with the most wonderful benefit to his own health: within one week the night-sweats had ceased, his cough abated, and expectoration diminished, he gained weight—nearly two stones in four months, and with the exception of being somewhat short-winded, looks nearly as strong and as able for ordinary work as before his illness" (Pamphlet, On the Application of Sulphurous Acid Gas, 1866). He reports four other cases of "chronic phthisis" equally benefited; and Pairman corroborates his observations; they deserve careful consideration, but up to the present there has been little further trial of the method. Additional favourable evidence in four cases has been given by Sombro.

Solland also reported excellent results, and Ley sought to modify the administration so as to make it less trying. As the fumes owe their opacity to some sulphur being sublimed but not oxidised, and some of their irritating qualities to the sulphuric acid generated by aqueous vapour and oxygen in the air, he burnt the sulphur in dry air and allowed twelve hours for the sublimed drug to be precipitated before entering the room; he found .01 to .008

a sufficient therapeutic dose, and this can be obtained and used *with a patient* by burning 2 or 3 gr. (not 10) to the cubic foot in a room whose walls have been *previously* fumigated in the above manner (*cf.* p. 373). Non-febrile cases are the best suited for this treatment, which promotes bronchial secretion and expectoration (*Pract.*, 1888).

It was thought that the sulphurous *spray* would be of great service in the relief of phthisical symptoms, but I have not seen important results from it, though it facilitates expectoration and may lessen laryngeal irritation; often, however, it is not well borne.

Fumigation in Infectious Disease, etc.—The burning of sulphur for the prevention or cure of infectious disorder long preceded any modern scientific inquiry. The Chinese esteemed it highly in prehistoric times. Ulysses, according to Homer, employed it to disinfect his palace after slaughtering the suitors, calling it “the remedy of all evils, and cure of all sores” (*Odyssey*, xxii., 481). Ovid praises it in the *Fasti*, and Pliny in his *Natural History*; but it is within quite recent years, and since the recognition of a “germ theory” in disease, that the systematic use of sulphurous acid has been placed upon a logical basis.

When cattle plague was epidemic Dewar obtained the best results from fumigating cattle sheds with the acid. His own cattle never suffered, and “a large dairy, notorious for thirty years for mortality amongst its cows (from pleura-pneumonia), and which for eight years of the then tenant’s occupancy had never been free from disease for a month, in which sixteen cows had lately died, the last one three days before fumigation began;—this dairy from that time till the date of writing had been perfectly healthy.” He states also that “an epidemic of diphtheria was cut short by it; two cases having occurred in one house within twenty-four hours, and no others after sulphur-fumigations.” Pairmain reports similar experience, but neither author, however earnest and truthful in reality, writes in such a manner as to convince the profession, and hence, perhaps, they have not widely influenced practice.

The variola epidemic, arrested on the coast of Iceland by Dr. Hjaltelin, seems admissible evidence of the value of the gas, though such arrest has by some been attributed to the quarantine and

isolation enforced. Twenty-two cases were brought on shore from the fishing vessels; seven were confluent; only one died (moribund on admission); *in no instance did the disease spread*. A workman employed in the hospital did not catch small-pox, although shortly after he proved susceptible to vaccination; in every case the attack was quickly and favourably modified: results which may fairly be connected with the treatment—constant use of sulphur fumes in the air, and the giving of sulphurous solution internally (B. M. J., ii., 1871).

Dr. A. W. Foote, during the last epidemic of variola in Dublin, endeavoured to carry out a thorough disinfectant treatment in his wards at the Meath Hospital, giving sulpho-carbolates as well as sulphurous acid, applying the latter locally, and burning sulphur three or four times a day; he treated fifty-nine cases, of which twenty-four were confluent, six semi-confluent, and eleven died, and he concluded that the treatment was of value, and that sulphur vapour acted “as a prophylactic,” but was irritating to bronchitic subjects. This fact is important, for in confluent small-pox, laryngitis is a serious complication.

On the other hand, we have to note unsatisfactory results from the use of similar treatment during an epidemic at Trinidad. Bakewell, though not furnishing many details, states that he treated twenty-five patients with sulphur-fumigations and sulphurous acid, apparently “without any effect” (1872).

The experience as to disinfection after scarlatina has been favourable (Fergus). Kenwood found that a 25 per cent. fumigation of sulphurous acid gas markedly inhibited but did not kill diphtheria bacilli, which however were killed by 50 per cent. In each case the observations were made at the end of four hours’ fumigation (B. M. J., 1896).

The acid bleaches vegetable colours, and corrodes metals, etc., but not so markedly as to cause inconvenience in practice. The pernicious effect on human air-passages, formerly attributed by high authorities to effective sulphur vapour, has been quite disproved. Dr. Angus Smith says: “This acid gas is an irritant, and causes coughing, which becomes painful and dangerous according to the amount used, and as it is destructive to animal structures it does not seem advisable to use it more than can be avoided” (On Disinfectants): such an opinion has doubtless told

against its use, but after the observations of Dewar, Pairman, Fergus and others, must now be modified.

Cholera.—The burning of sulphur fires round infected villages has been strongly urged (Tuson, *Lancet*, ii., 83).

Mode of Fumigating with Sulphurous Acid Gas.—Dewar, referring more particularly to the process as applied for cattle plague, recommends as the safest and most convenient apparatus, “a chaffer two-thirds full of red cinders, a crucible inserted therein, and a piece of sulphur stick”—a piece the length of a man’s thumb will burn for twenty minutes and be sufficient for a shed containing six cattle, and if ventilation be free at the same time a man can remain without the least risk of detriment—this is repeated three or four times daily. Its efficacy is increased by simultaneous steam-fumigation, and if only “inanimate objects” are to be disinfected, nitre may be added to the sulphur, and thus some sulphuric acid generated. The more recent experiments of Wolffhügel which have been already referred to (p. 365) show also that a solution of the gas is more powerful as a germicide than the gas in a dry state.

For phthisical and other patients, the room is simply filled with fumes three times a day. Pairman placed half a teaspoonful of sulphur on paper on a shovel and ignited it, repeating this process every twenty minutes till the patient had had one or two hours of fumigation;—the head was not to be held too near, nor the fumes made so strong as to excite much coughing. He was in favour of keeping “mild sulphur fumes almost constantly in the sick room,” but the occasional and temporary use of a full dose was to be preferred. Foote used “flowers of sulphur” dropped on a heated shovel, and carried about the room, and this was quite under control and readily borne by patients unless bronchitis or asthma rendered them unusually sensitive; from 1 to 2 dr. was considered to be an average quantity. (This method hardly seems reasonable; the acid is acknowledged to be useless for tubercle bacilli, as for spores.)

If a room is to be thoroughly disinfected in the absence of inmates, the doors, windows and other apertures should be closed—pasting paper over chinks is sufficient—coloured clothes removed, and metal protected by grease or otherwise; then sulphur should be burnt in quantity proportioned to the space, taking Letheby’s

estimate of $1\frac{1}{2}$ oz. for each 100 cubic feet, or more roughly the proportion of $\frac{3}{4}$ lb. for a large room. If dried and finely powdered it will burn when lighted, and may be conveniently placed in a small earthen jar standing in water: mixed with $\frac{1}{10}$ part of its weight of powdered charcoal it burns, perhaps, more readily, and will not melt and run over—the charcoal will be unconsumed (Fergus). If this mixture be placed on an iron plate two feet square it will be safe, though for precaution some would put the plate or vessel over water. The doors and walls may have previously been washed with a solution of carbolic acid. After an hour's fuming a free current of air should be admitted for several hours before occupying the room. Candles are made with a definite proportion of sulphur, and there is an apparatus for local application of the vapour. Keates suggests the burning of bisulphide of carbon as a convenient means of obtaining gaseous sulphurous acid, for much more of this gas is given off than of carbonic acid—especially is this the case if petroleum be mixed with it. In a room of 1,300 cubic feet, 280 gr. of bisulphide charged the air so efficiently with SO_2 that one could not remain in it: a lamp has been contrived to burn a graduated amount. It is said too that the offensive smell of bisulphide is got rid of in the purer preparations, but still it remains highly inflammable, and the method is more dangerous and more complex than simple sulphur burning.

THERAPEUTICAL ACTION.—*Internal.*—**Septicæmia.**—Following up the observations already mentioned as to the effect of sulphites upon dogs, Prof. Polli devised a special method of treating zymotic diseases—the “anti-fermentative or anti-zymotic method,” which aimed at prophylaxis by saturating the blood with these remedies. The method made progress in Italy, Spain and France, not much in Germany, and lately it has lost ground even in the former countries. It is applied not only to the specific fevers, but also to pyæmia and septicæmia generally, to phthisis with suppuration and chronic empyema, all of which have been benefited by sulphites.

McCall Anderson cured eruptions of furunculi with $\frac{1}{2}$ -dr. doses of sulphite of sodium, and Dr. Ricci chronic pemphigus with sulphite of magnesium. C. B. Radcliffe, when suggesting the use of the same salt in cattle plague, states that he has seen good results from it in fevers (Lancet, i., 1870).

Snow Beck used frequent vaginal injections of sulphite of sodium in puerperal fever, and gave internally the sulphites of lime or magnesium, and advocated this treatment as better than any other. Sulphite of sodium in 2-dr. doses daily (readily taken in beef-tea) proved valuable in pyæmia in the Liverpool Infirmary; and Millar, whilst reporting the hyposulphite ineffectual in typhus, found it distinctly of service when given early in septicæmic cases connected with parturition (Edin. Journ., Sept., 1869). Sir Spencer Wells had preceded him in this observation (1864). Since these observations the antiseptic principles of treatment have much advanced, but are carried out with other remedies. Of course, if blood poisoning has reached beyond a certain point, recovery is not possible under any treatment, and if the salts employed be not fresh and pure, irritation of the stomach and intestinal tract may also hinder their employment; I think that sulphurous acid is really a better form to employ than its alkaline compounds; but whichever be chosen, for any chance of success, it should be *early* and thoroughly given.

Variola.—We have already stated that in the hands of Hjaltekin and A. W. Foote, the internal use of sulphurous acid solution in small-pox was combined with the external application of the gaseous form, and with good effect. The secondary fever of this malady is due to absorption from the pustular eruption, and this ought to be influenced by the early employment of such remedies, and I believe is so influenced. In one exceedingly severe case of confluent small-pox, considered hopeless by a good practitioner, the patient was enabled to take $\frac{1}{2}$ -dr. doses of sulphurous acid every hour or two, and within a short time showed signs of improvement, which went on to complete recovery, not in accord with the normal rate of progress in such cases. For variolous pustules maturing, the acid with glycerin is a good application.

Erysipelas.—The relief afforded by the acid spray in erysipelas has been already noted, but the internal use of the remedy may be well conjoined with the external. In the case of an infant living under unhealthy conditions, and in whom a severe attack of the idiopathic malady affected one arm and leg, the pudenda and head, and when iron had no control over it, the internal use of sulphurous acid seemed the cause of improvement which quickly followed.

Diphtheria.—Under sulphur it has been stated that the local application of that remedy is not desirable, but sulphurous acid acts much better, and is, as a rule, well borne, and even liked by the patient; it may be used in fumes, spray, or gargle, and conjoined with iron or chlorate of potassium.

I think the local application of the acid in spray highly desirable, and that painting the throat with a mixture of equal parts of the pharmacopœial acid and glycerin often aids the separation of the membrane in this disease. This method may be used in conjunction with the anti-toxin treatment.

Enteric Fever.—Whilst recognising the difficulty of a true judgment about the effect of medicines in this fever on account of some uncertainty in its natural course and duration, and of the usual recoveries independently of any specific treatment, yet I must state my conviction that its course may be favourably influenced by the internal use of sulphurous acid, if commenced *early* enough. I know that many authorities have taught that the *materies morbi* having once been received must pass through certain changes before elimination, and that the best practice is mainly intelligent nursing; but observation of many enteric cases has led me to the conclusion that under the influence of sulphurous acid or the sulphites, the attack has been shortened, whilst high temperature and profuse diarrhœa have been relieved, coincidently with improvement in the general symptoms. In some advanced cases, with muttering delirium, sordes, and signs almost of dissolution, a favourable change has occurred shortly after commencing the acid treatment, though it cannot be depended upon if commenced only at this stage. Of thirty-six consecutive cases thus treated by Dr. Mackey, several illustrated these points, and none died.

It is true that sometimes vomiting interferes with its administration, and the 1-dr. or 2-dr. doses recommended cannot always be given; 10 to 30 drops have been an average dose for an adult, repeated every two to four hours, and if urgent bronchitis contra-indicates this remedy for a time, expectorants and diaphoretics must be substituted. Several years ago, Dr. Hamilton (Liverpool), treating his last eight cases of an epidemic of typhoid with sulphurous acid, "was struck by the mild form assumed, and apparent cutting short of the fever."

They were typical cases at the commencement—five children, three adults—and the dose was from 1 to 3 dr. ; they were generally better on the second day, and by the fifth day improvement had set in (*Lancet*, i., 1869). Wilks, of Ashford, refers to 171 cases of enteric fever treated by him with sulphurous acid, and all ending in recovery, some under very unpromising conditions ; thus he instances a poverty-stricken child of four years, with violent vomiting, purging, tympanites, and delirium, who could not have ordinary care and attention ; a woman of seventy-three equally neglected ; and a man of fifty-four apparently dying under the ordinary treatment by astringents, etc., and yet rapidly recovering after commencement of the acid treatment (*B. M. J.*, ii., 1870). The patients took from 4 to 40 drops with syrup and water every four hours for many days, until they showed ample evidence of the absorption and elimination of sulphur.

Scarlet Fever.—In an epidemic of malignant type Dr. McDonald found this acid, used internally, in spray, and in fumigation, more effective than any other remedy (*B. M. J.*, i., 1883).

Dysenteric Diarrhœa.—Cholera.—Dr. Scoffern commends the sulphite of lime in choleraic diarrhœa, but it has not been much used. On the hypothesis of cholera being dependent upon the absorption of organic poison produced by the comma bacillus, sulphurous acid ought to prove of service in its treatment, more so than the sulphites and hyposulphites, which are slower in action and liable to irritate. Professor Graham, indeed, first introduced the solution of sulphurous acid as a possible remedy for cholera, but it has never received full trial. A main difficulty, as regards any remedy in cholera, is to secure its absorption, vital function being reduced with such fearful rapidity : hence we can never hope for the same results as in enteric fever, but sulphur fumes may certainly be used as a disinfectant and prophylactic.

It has been pointed out that workers in copper, and in powder factories (at Madras especially), have shown special immunity in cholera epidemics ; and although Dr. Burq claims specific virtues for copper in this respect (*v. Cuprum*), the presence of sulphurous acid is a more likely explanation.

Ague.—In view of the accepted parasitic causation of mala-

rial disease, it is interesting to note that clinical evidence as to the value of sulphite treatment is contradictory—thus, whilst Sanger refers to four cases of intractable ague, soon relieved and ultimately cured by scruple doses of hyposulphite of soda, McClean criticises the result, and notes that quinine and other remedies had been previously used, and that it is well known quinine often does not cure, unless a blood depurant, such as potash or soda, first be given, and moreover many cases in the Mauritius were treated by the sulphites without effect, and were afterwards cured by quinine. Several American writers have reported the cure of intermittents by hyposulphites after failure of quinine; but Farelli, from an exhaustive analysis of the recorded evidence, concludes that their good effect is neither so quick nor so constant as that of the latter; they are not prophylactic, and their continued use leads to anæmia.

Syphilis.—Several writers, chiefly American, have strongly recommended the internal and external use of sulphites in the later stages of syphilis. I have had no occasion to prescribe them, but have found the acid locally applied useful in ulcerations of the throat and other parts.

Pyrosis.—Sarcinous Vomiting.—In these conditions, which are dependent upon fermentations induced by low organisms, the influence of sulphurous acid and its compounds ought, *a priori*, to be clear; and so practically we find it, for sulphurous acid in $\frac{1}{2}$ to 1 dr. doses freely diluted is one of the best remedies that can be given. Sir William Jenner was one of the first to point this out (*Med. Times*, ii., 1853), and Dr. Henry Lawson, one of the first to secure for it the attention of the profession (*Pract.*, vol. i.).

PREPARATIONS AND DOSE.—*Acidum sulphurosum*; dose, $\frac{1}{2}$ to 1 fl. dr., diluted. For external application the solution may be used in full strength, or diluted with equal parts of glycerin and water, or as a lotion 1 part in 8. *Sodii sulphis*: dose, 5 to 20 gr., freely diluted: as a lotion (antiparasitic), 1 part in 8: as an injection, etc., 2 dr. to $\frac{1}{2}$ oz. in 8 oz. of fluid. *Sodii hyposulphis thiosulphate* (not off.): dose, 3 to 10 gr. *Magnesiæ sulphis* (not off.): dose, 10 to 30 gr.: gargle 1 part in 16, or in powder locally.

AMMONIUM ($\text{NH}_4 = 18$).—AMMONIA ($\text{NH}_3 = 17$).

Ammonia exists in the air in minute quantity, about 1 in 1,000,000, in sea-water, many mineral waters, and rain-water; in the soil and in animal excretions, especially the urine. It is a usual product of decomposing nitrogenous matter, and is said to occur free in certain plants, as in the leaves of aconite and the root of hellebore. The chloride is found native near volcanoes and in many coal mines.

Its salts are commonly obtained from "gas-liquor," a product of the distillation of coal in gas manufacture: when this is neutralised by hydrochloric acid it yields a chloride, NH_4Cl (sal-ammoniac), and from this salt, when purified, are derived all the other ammonium compounds used in medicine.

The hydrogen atoms in ammonium may be replaced by organic radicals giving the class of substances known as amines and amides.

CHARACTERS.—Ammonia itself is a colourless gas, which may be liquefied and is then of bluish colour. It has a pungent odour and alkaline reaction; it forms salts with acids, and as these are very analogous in chemical relations to salts of potassium and sodium, it is believed that they have a metallic base, which is named ammonium, and is the fundamental radical of the series. But while potassium and sodium are *simple*, ammonium is a *compound* body or radical (NH_4).

LIQUOR AMMONIÆ FORTIS—LIQUOR AMMONIÆ.

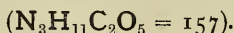
These are solutions of ammonia gas in water, the former containing 32·5 per cent., and being about one-third stronger than the simple liquor; they are commonly called "spirits of harts-horn," because formerly prepared by heating scrapings of horns and hides. The liquor ammoniæ (B.P.) contains 10 per cent. by weight of ammonia (NH_3).

CHARACTERS AND TESTS.—The strong solution is colourless, of sp. gr. ·891, of characteristic pungent odour and alkaline reaction. A piece of moist red litmus paper held in the neck of the bottle is at once turned blue. *The tests for its purity are*—When diluted with four times its volume

of water, it gives no colour or precipitate (a) with lime water, showing the absence of carbonic acid; or (b) with oxalate of ammonium, showing the absence of lime; or (c) with sulphide of ammonium, proving its freedom from lead, copper, and other metals; or (d) with ammonio-sulphate of copper, showing its freedom from sulphuretted hydrogen. (e) When rendered acid by excess of nitric acid, it gives no precipitate with nitrate of silver or chloride of barium, showing its freedom from chlorides, bromides, iodides, cyanides, phosphates, and sulphates.

COMPOUNDS OF AMMONIUM.

AMMONII CARBONAS—CARBONATE OF AMMONIUM



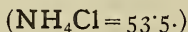
This is a compound of acid carbonate (NH_4HCO_3) with carbonate of ammonium ($\text{NH}_4\text{NH}_2\text{CO}_2$) and is generally considered to contain one molecule of each of these salts.

CHARACTERS.—When recent it is in colourless, translucent, crystalline masses, of strong characteristic odour and acrid taste, markedly alkaline in reaction, volatile, soluble in water, less so in spirit, and effervescent with acids. When exposed to the air it gives off ammonia and carbonic acid, loses its odour, and crumbles into an opaque mass of bicarbonate of ammonium. (This is sometimes prescribed as more palatable—it occurs in minute white crystals, solubility 1 in 8.) In consequence of ready decomposition, the aqueous solution of the ordinary salt will contain both neutral and acid carbonates. The neutral salt has not been isolated in the solid state.

SPIRITUS AMMONIÆ AROMATICUS—SAL VOLATILE.

Is prepared with the carbonate of ammonium, the *strong* solution of ammonia, the oils of nutmeg and of lemons, 90 per cent. alcohol, and water, sp. gr. 0·888 to 0·893.

AMMONII CHLORIDUM—CHLORIDE OF AMMONIUM—SAL-AMMONIAC.



CHARACTERS AND TESTS.—It occurs in pieces of the hemispherical cakes in which it is sublimed, of translucent fibrous appearance and pungent saline taste without odour. Its ordinary form is difficult to powder. It is soluble in one part of boiling water and three of cold, its solution being attended by reduction of temperature; it is also soluble in rectified spirit. Heated with potash, soda, or lime, it evolves ammonia.

*AMMONII BROMIDUM (v. BROMINE).**LIQUOR AMMONII ACETATIS—SOLUTION OF ACETATE OF AMMONIUM.*

Acetate of ammonium ($\text{NH}_4\text{C}_2\text{H}_3\text{O}_2 = 77$) dissolved in water. This is often called Mindererus spirit.

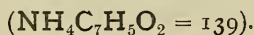
CHARACTERS AND TESTS.—When pure and fresh, it is a limpid, colourless liquid, without odour and with strong saline taste, but unless carefully kept it soon spoils: it may be slightly acid to test paper.

LIQUOR AMMONII CITRATIS—SOLUTION OF CITRATE OF AMMONIUM.

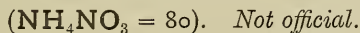
Citrate of ammonium ($(\text{NH}_4)_3\text{C}_6\text{H}_5\text{O}_7 = 243$) dissolved in water. It is a colourless liquid of saline taste.

AMMONII PHOSPHAS—PHOSPHATE OF AMMONIUM

CHARACTERS AND TESTS.—The crystals, which are transparent when recent, become opaque on exposure, and part with ammonia and water. They are soluble in water, insoluble in spirit, and their aqueous solution gives a characteristic yellow precipitate with nitrate of silver.

AMMONII BENZOAS—BENZOATE OF AMMONIUM

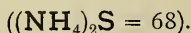
CHARACTERS AND TESTS.—It occurs in colourless laminar crystals, which are soluble in water and alcohol: they are sublimed by heat. Hydrochloric acid precipitates benzoic acid from the solution, and caustic potash heated with it causes evolution of ammonia. Ferric salts give a yellow precipitate.

AMMONII NITRAS—NITRATE OF AMMONIUM

CHARACTERS AND TESTS.—It is a white deliquescent salt, which occurs in confused crystalline masses. It has an acrid taste, is soluble in less than its own weight of water, and is only sparingly soluble in rectified spirit. It is neutral in reaction. Heated with caustic potash, it evolves

ammonia; with sulphuric acid, it emits nitric acid vapour. It fuses at 320° F. (160° C.), and at 350° F. to 450° F. (176°-232° C.) it is entirely resolved into nitrous oxide gas, and the vapour of water. It is only used for the preparation of nitrous oxide.

*AMMONII SULPHIDUM—SULPHIDE OR SULPHYDRATE OF
AMMONIUM (APPENDIX II.) TEST SOLUTION*



It is a colourless liquid, becoming yellow when kept, of disagreeable taste and fœtid odour. It is incompatible with almost all metallic and acid solutions.

ABSORPTION AND ELIMINATION.—Ammonia and its carbonate are not wholly absorbed as such—a part becomes changed into chloride in the stomach (Rabuteau). Sticker has given evidence to show that ammonia is not normally produced in the stomach, but is derived from saliva swallowed with food (Amer. Journ., 1897), and it has also been stated that the excretion of ammonia in suckling infants is much increased in intestinal disorders on account of much acid being formed by the fermentation of milk, especially the fat of milk (B. M. J., Epit. ii., 1897).

Though Lange did not find ammonia in the air expired by animals taking it (Archiv f. exper. Path., Bd. ii.), other observers have often done so, and Bellini concluded that caustic ammonia and the carbonate, when taken in small doses, were entirely and very quickly *eliminated by the lungs*; of large doses, some passed also by other channels. Whatever salt was taken, carbonate was eliminated by the lungs.

There is sufficient evidence that the carbonate, when taken in moderate or even large doses, is not excreted as such by the kidneys. Rabuteau took 60 gr. daily for five days without finding any in the urine, which continued acid, whereas a mere trace of ammonia added *directly* to the urine suffices to give an alkaline reaction. Dr. Bence Jones had previously pointed out this continued acidity of urine under ammonia, and suggested that the drug becomes so far oxidised in the system as to give rise to nitrous or nitric acid, which appears in that secretion. Only after very large doses (160 gr. daily) *some* carbonate of ammonium is eliminated in the urine, which then becomes alkaline, and deposits ammonio-magnesium phosphate.

Ammonium *chloride* does not readily decompose in the system; it is excreted by the urine and partly by the saliva (Rabuteau); a small quantity passes out by the skin.

As a result of more recent researches, it has been shown that ammonia administered in the form of carbonate or organic salts is converted within the body chiefly into urea, and that only a small portion is excreted unchanged. Ammonium chloride, owing to its strong chemical combination, is excreted in the urine of carnivora for the most part unchanged, whereas, in herbivora, it is partly converted into urea (Knieriem, Salkowski, Schmiedeberg, Corandra, v. Schroeder) (*v. p.* 397).

Frerichs taught that in uræmia an unusual amount of ammonium carbonate (arising from decomposition of urea) circulated in the blood and was excreted by the lungs, but although such an excess may be present, and although ammonium carbonate injected into the circulation will produce convulsions and dyspnoea (*v. p.* 385), many observers have failed to detect it in the blood of fatal cases, and ammonia is not now regarded as the cause of uræmia. Sir B. W. Richardson pointed out that during an *actual attack* of uræmic convulsion, the amount of ammonia excreted is less than at other times, on account of the retention of urea in the system. Gull found ammonia when the albumin in the urine was not large in amount. Uræmic coma is, however, connected with the circulation of urea, or more probably some of its antecedents—"an excess of nitrogenous extractives" (J. R. Bradford)—rather than of ammonia.

PHYSIOLOGICAL ACTION.—*External.*—The vapour of ammonium carbonate (smelling salts) is stimulant and slightly irritant, that of the strong ammonia is intensely irritant to the whole of the air-passages and conjunctivæ, and has even caused fatal bronchitis. Liquid ammonia is also a strong local irritant; diluted with oil it is rubefacient, but applied in strength, and when evaporation is prevented, it vesicates, and if injected under the skin causes severe sloughing. Oertel reported that the direct application of liquor ammoniæ to the air-passages caused a membranous effusion similar to that of croup; but careful observations by Meyer on the same point verified only a local catarrhal inflammation and hæmorrhage (B. M. J., ii., 1874). Ammoniacal urine commonly irritates the bladder.

Ammonia has marked antiseptic powers: 1 dr. of the strong solution of ammonia on lint under a bell-jar preserves morbid specimens, and the same quantity with water preserves them better than spirit. A solution of 2 to 10 per cent. of carbonate was found to delay decomposition and to kill organisms, though a less proportion favoured their growth (B. M. J., i., 1889).

PHYSIOLOGICAL ACTION.—*Internal.*—**Circulatory System.**—Medicinal doses of ammonia and its compounds quicken the heart's action and capillary circulation, but only for a comparatively short time: such stimulation is not always marked in healthy persons—it is more evident in the weak and in invalids: there is increased sense of warmth, the face becomes flushed, the eyes more brilliant, and the mental condition stimulated. This effect is partially due to the rise of blood pressure which ammonia brings about. Dr. E. P. Brewer concludes that the stimulant properties of carbonate of ammonium are due to the liberation of ammonia when the salt comes in contact with the hydrochloric acid of the gastric juice; it is the most useful salt, as it is most easily decomposed in this way (Pract., i., 1883).

Ten drops of the liquor, diluted with 1 or 2 oz. of warm water and *injected into a vein*, excite the heart so powerfully as to rouse a patient from a state of collapse (Med. Times, ii., 1872). Larger quantities—30 drops—given in the same manner, after a momentary arrest, stimulate intensely, and may induce convulsions: still larger quantities cause momentary fall of arterial pressure, then sudden and enormous rise, with corresponding increase of pulse-rate: this result occurs equally after division of the cord, hence it is not due to stimulation of the vaso-motor centre, but of the accelerator nerves of the heart (Lange).

On the other hand, according to Rabuteau, 40 gr. of *carbonate* dissolved and *injected into a vein* weaken the cardiac contractions and render them irregular, whilst 60 gr. cause a sudden arrest of the circulation, the heart-muscle being paralysed.

Drs. Ringer and Sainsbury have contrasted the action of salts of ammonium with that of potassium and sodium salts on the frog's heart, and they find: (1) that potassium salts are the most poisonous, both excitability and contractility being powerfully affected; (2) that ammonium salts come next, the excitability of the heart not being affected, but contractility powerfully so; (3)

that sodium salts affect excitability slightly, and contractility to a rather greater extent (Lancet, i., 1882).

The corpuscles are altered by toxic doses; they cease to contain the normal quantity of oxygen, and do not absorb it even when shaken up with the gas (Feltz and Ritter). The continued use of ammonium salts causes similar toxic effects; the pulse becomes very feeble, and the corpuscles pale and wasted, as after typhoid fever; this is but the recognised effect of all alkalies.

Ammonia or the carbonate added to blood outside the body renders or keeps it fluid, and when given internally exerts an influence in the same direction; and has been said to have sometimes caused disintegration of clot already formed in the vessels (*v. p.* 392). Coagulation of blood is not, however, due to escape of ammonia, as was thought probable at one time, nor will ammonia always or wholly prevent it. A difference in *time* of coagulation was the only difference observed by Rabuteau in experiments on dogs, for whilst coagulation of their blood usually occurs in two minutes after withdrawal, it occurred only in ten minutes when 60 gr. of ammonium carbonate had been injected: the clot, however, was firm and resistant.

Chloride of ammonium delays coagulation of the blood, and when added to it, in the presence of air, renders or keeps it red, as do other chlorides.

Nervous System.—Ammonium salts in medicinal doses stimulate the general nervous system, but the special effect of large doses is exerted on the motor tract of the spinal cord, which is stimulated much in the same manner as by strychnine. Convulsions are produced, especially by strong intravenous injection and as these occur equally when communication with the brain is severed, they are not cerebral in origin (Lange): neither do they start in the peripheral nerves, for they take place if the blood be cut off from these nerves by ligature (Funke): we conclude them, therefore, to be of spinal origin (Pflüger's Archiv, Bd. ix.), and section of the nerve-trunk of a limb stops their occurrence in that limb. Prostration follows the convulsive seizure, and a partial paralysis of the hinder limbs of animals (Comptes Rendus, Soc. Biol., 1873). Spiegelberg made certain experiments in order to test the opinion of Frerichs that the convulsions of albuminuria were due to the circulation of ammonium carbonate, and when he

had injected as much as 6 gr. of that salt into the veins of a dog, general convulsions occurred with clonic spasm and trismus, the pupil was dilated, general sensibility was reduced, and coma set in; after an hour and a half, free salivation and urination took place, and the animal recovered, remaining stupid for some time: larger doses caused vomiting, afterwards tetanus and coma; the vessels were found full of dark fluid blood (Lancet, ii., 1870). It is probable that ammonia is a direct and intense *stimulant of the respiratory centres* in the medulla.

The effect of ammonia on the circulation when applied to the nose is a reflex one, for it stimulates the nasal branches of the fifth nerve, and thus reflexly excites the vaso-motor centre; it has much more effect on this than on the higher centres, differing in this respect from alcohol.

The full effects of *chloride of ammonium* are not often exemplified, but in the case of a lunatic who swallowed a large (unknown) quantity, there were vomiting, giddiness, shivering, depression, delirium, convulsion, and later collapse so complete as to simulate death: recovery was effected with galvanic and other powerful stimuli, and then tetanic spasms came on (Sir J. Crichton Browne, Lancet, i., 1868). This salt has a paralyzing effect on the muscles, which modifies the tetanus caused by other ammonium compounds. Temperature is raised under the physiological action of the chloride; lowered under that of the other salts.

Digestive System.—Ammonia and the carbonate have a direct antacid effect on the gastric secretions, and moderate doses induce a sense of warmth and stimulation at the epigastrium. More than 5 gr. is likely to irritate; 10 gr. will commonly nauseate, and 20 gr. will usually produce vomiting. Intestinal catarrh is sometimes observed from continued medicinal doses, which also are apt to impair digestion by neutralising the gastric juice. Liquid ammonia, when swallowed, acts as an irritant poison, causing salivation, dyspepsia, ulceration of mouth and tonsils, and in fatal cases inflammation and erosion of the upper part of the alimentary tract: occasionally it has acted upon the larynx, and induced rapidly fatal œdema glottidis. Death has been caused by 2 dr. of the strong solution; in other cases by 1 oz. and $\frac{1}{2}$ pint (B. M. J., i.-ii., 1878). It has also followed inhalation of the gas from a solution used for cleansing, or from bursting of the

pipe of a refrigerating apparatus, causing bronchitis (as well as eye inflammation). Sixty-four accidental deaths and thirty-four suicides by ammonia were recorded in ten years (B. M. J., i., 1896).

Secretion and Excretion.—Medicinal doses of ammonia, under favourable conditions of warmth, etc., increase most of the secretions, such as those of the skin, the kidneys, and the bronchial and intestinal mucous membranes. The liquor ammonii acetatis has a special action on the skin and kidneys, the carbonate on the lungs, the chloride on the liver and kidneys. The pulmonary secretions and the bile are also rendered more fluid, ammonium chloride especially stimulates the latter secretion. The alkaline salts of ammonia are not “remote antacids,” *i.e.*, they do not render the urine alkaline, because they are excreted as urea.

Influence on Nutrition.—Although ammonia is seldom taken long enough in medical practice to directly affect nutrition, there is evidence that its continued use will produce debilitating effects like other alkalis—as indeed might be expected from its influence on the blood. Cazenave has reported pallor, anorexia, debility, and emaciation (Bull. de Thérap., t. xxxi.); and Huxham, a case in which hectic, hæmorrhage, and general marasmus followed upon the habitual eating of ammonium carbonate (Essay on Fevers). Richardson maintains that ammonia suspends oxidation, checks formation of all downward products of albumin, and retards nutrition (Med. Times, i., 1862; ii., 1866); yet Pereira has given 15 gr. thrice daily for two months without apparent injury, and often a scruple thrice daily for two or three weeks, and in one case Dr. Lionel Beale gave 55 gr. daily for a year (Lancet, ii., 1884). Under the chloride, urea is distinctly increased, and oxidation of tissue rendered more active. The iodide and bromide of ammonium exert the absorbent and sedative effects of alkaline bromides generally; if anything, they are more active and less depressing than the corresponding salts of sodium and potassium.

SYNERGISTS.—Diffusible stimulants, heat, and, according to Gubler, opium and iodine. Both Gull and Paget have pointed out that ammonia aids the action of potassium iodide, and it has been asserted that 5 gr. of the latter with 3 gr. of ammonium

carbonate are equivalent to 8 gr. of the iodide alone (B. M. J., i., 1874). Volatile ammonia assists also the action of antispasmodics, such as valerian; other alkalies and bases assist its antacid power.

ANTAGONISTS. — INCOMPATIBLES. — Cold, emollient drinks, and tannin, interfere with the action of ammonia, and are “dynamic antidotes” (Gubler).

Incompatibles are acids and fixed alkalies, salts of iron (except the tartarated iron), calomel, lead salts, etc. Freely diluted, ammonia and its carbonate may be used as antidotes to mineral acids. Christison, Pereira, and others, consider them also antidotal to prussic acid: they certainly have dynamic effects, opposite in character to those of the acid, though they do not chemically neutralise it: they antagonise also the toxic effects of alcohol, and in some degree those of animal poisons.

THERAPEUTICAL ACTION.—*External.*—**Neuralgia.**—**Rheumatism, etc.**—The strong liquor ammoniæ has been used as a counter-irritant, or a rapid vesicant, in cases of muscular, neuralgic, and rheumatic pain, and to relieve deeper-seated inflammation, for instance, of the tonsil and fauces, by derivation to the skin. For such purposes the ammonia liniment may be rubbed in, or if vesication be necessary, it may be secured in the course of five minutes by the strong liquor applied on lint. Dr. Waring recommends, as a simple method, to fill the lid of a wooden pill-box with circular pieces of lint to above the rim, saturate them with the liquid and invert over the part. M. Gondret introduced a vesicating ointment made with ammonia and one-fourth part of lard and olive oil, and it is commonly used in France. M. Ducros advised painting the liquor over the palate and gums for relief of tic.

Falling of the Hair.—The stimulating properties of ammonia are highly useful in promoting growth of hair when it has been thinned by debility or illness. Half an ounce of the strong liquor with almond oil, rosemary spirit, and honey-water to about 6 oz. is a good proportion.

Amenorrhœa.—Pruritus.—In cases of chlorotic amenorrhœa, a stimulating vaginal injection of about 1 dr. of the liquor ammoniæ to a pint of warm milk has been found useful by Dr. Ashwell, and I have frequently ordered it with advantage, the breasts being stimulated at the same time by friction with weak

ammonia liniment. Dr. Dewees has recorded the cure of an obstinate case of pruritus pudendi by a similar injection. In cases of amenorrhœa general tonic treatment must also be employed.

Local Inflammations.—Lotions containing ammonium chloride are very useful in inflammatory swellings of muscles, joints, lymphatic and other glands, and sometimes in the hydroceles of children—2 dr. may be used to 4 or 6 oz. of spirit and water.

In *orchitis* and in cases of *engorgement* of the breasts with milk the same application is cooling and absorbent. Guéneau de Mussy recommends for the latter cases an ointment containing 5 parts of the chloride mixed with 1 of camphor and 30 of lard, to be used frequently.

Acne.—In chronic cases of acne simplex with comedones, a lotion containing the chloride with alum and sulphuret of potash is sometimes an effective resource: it is liable to irritate.

Stings.—Snake-Bite.—Dilute liquor ammoniæ relieves the pain that follows the sting of venomous insects, wasps, etc.; it should be freely rubbed into the part, and given internally if there be tendency to collapse.

Professor Halford (Melbourne) strongly advocated *intravenous injection* of ammonia in snake-bite, using 15 to 30 min. of the liquor, diluted with 3 or 4 parts of water, both as antidotal to the poison, and as a general stimulant. Many cases have recovered under this treatment, but there is yet much doubt as to how far it may be depended upon; in some of them it is probable that the bites were not of fatal character, and when experiments were repeated with more accuracy, ammonia did not avert a fatal result (Med. Times, ii., 1876). It has also been found powerless against the bite of Indian snakes (Cobra, Dabois), which are more poisonous than those of Australia; in some cases death followed even more quickly than usual after the injection (Report of Commission).

Shock.—Collapse.—The intravenous injection of liquor ammoniæ is a subject of much importance, and deserves more attention than has yet been given to it; it is not free from risk and danger, especially if the large dose of 30 min. be used, but in suitable quantity it has powerfully stimulated the heart, and revived cases apparently in articulo mortis (v. p. 384). In a severe case of coma,

cyanosis, etc., due to sewer gas poisoning, 35 min. of the strong liquor ammoniæ (by mistake for the weaker form) were injected, undiluted, several times into a superficial vein in the arm, not only without injury, but with the best effects; it was presumed that clot had formed in the heart-cavities (Eskridge, Record, 1883).

Cases of fracture and laceration accompanied with collapse and treated by injections of ammonia have been recorded. In one man, 40 drops with 2 oz. of warm water were passed into one of the veins of the arm, and after temporary arrest of breathing, a violent convulsion occurred; but on subsidence of this, general stimulation was evident, and he rallied for several hours. In a second case, 30 drops were injected, with a somewhat similar result; in the third patient, when only 10 drops were given, pulse and respiration were at once restored, vomiting occurred, and recovery followed (Med. Times, ii., 1872). Recovery, though only temporary, followed similar injections (5 to 8 min. of strong solution of ammonia, undiluted, into the median vein) given during collapse in severe *scarlet fever* (B. M. J., i., 1877), and in the same condition, occurring during *puerperal fever*, Tyler Smith injected 30 min. with 3 parts of water, and ultimate recovery followed; but two cases thus treated by Sir Spencer Wells proved unsuccessful (B. M. J., ii., 1869). In a case where extreme exhaustion was consequent on prolonged suppuration, 15 min. (undiluted) were injected into a vein, and again eight hours afterwards with permanent good result (B. M. J., i., 1877); some of the caustic entered the cellular tissue, and caused local sloughing, and in other cases, where injection has been made purposely into this tissue, serious ulceration and abscess have followed (Med. Times and Lancet, i., 1870); 1 part in 2 of water is a safer injection.

Anthrax.—Dr. L. Avendano of Peru regards ammonia as a specific in this disease. If the case was seen early, the pustule was incised, and a drop of liquor ammoniæ introduced; some ammoniacal salt, such as the acetate, being given internally. He records cases of persons who were moribund in the later stages of the disease and were apparently cured by intravenous injections of ammonia (Lancet, i., 1886).

Narcosis.—Neild injected 30 drops of ammonia into the median cephalic vein on four separate occasions in a patient

fatally narcotised by chloroform; temporary recovery occurred each time (Med. Times, i., 1871). In a case of opium-poisoning, when 40 gr. had been taken, and death was imminent, revival, though only for a time, also followed directly on ammonia-injection (B. M. J., ii., 1872). Mr. Richards has specially drawn attention to the value of ammonia-injections in *alcoholic coma*, and has shown that some of Dr. Halford's patients who had much brandy (one got a bottle and a half in three hours) were really more comatose from the alcohol than from the bite, and hence their recovery; he remarks on the importance of a slow injection, and recommends 10-min. doses (Lancet, i., 1880).

THERAPEUTICAL ACTION.—*Internal.*—**Exhaustion.**—**Alcoholism, etc.**—One of the most frequent uses of ammonia, and one which it commonly serves very well given by the mouth in the ordinary manner, is to quicken the general circulation and to revive failing cardiac action in cases of exhaustion and threatened syncope from almost any cause; being volatile, it diffuses and acts rapidly. The vapour of the carbonate, as disengaged from "smelling salts," is sometimes usefully given by inhalation in the same class of cases, and the vapour of liquor ammoniæ has been utilised in partial asphyxia, and in the semi-coma of drunkenness. In several extreme cases of alcoholism, wherein relapses were frequent, I have known the aromatic spirit of ammonia, in drachm-doses every hour or two, "steady" the patient very markedly: it has acted better than, *e.g.*, vinegar, which seemed to increase congestion of the liver and give only temporary relief to symptoms. The depression and dyspepsia which commonly follow excessive use of alcohol are also well treated by ammonium compounds, especially if combined with valerian; in the prostration of delirium tremens, the same remedies are very useful.

Thrombosis.—**Embolism.**—Rapid separation of fibrin in the cavities of the heart seems to occur previous to death in many acute exhausting diseases, such as pneumonia, croup, peritonitis, etc., and after prolonged or difficult parturition. The late Sir B. W. Richardson states that advantage may be derived in such apparently hopeless conditions from the internal use of liquor ammoniæ, 10 min. every hour, alternately with iodide of potassium (Ranking, ii., 1872). The late Dr. Shepherd Fletcher has reported

a well-marked case of embolism occurring in a puerperal woman and recovering under 5-gr. doses of ammonium carbonate given every hour (B. M. J., i., 1864), and Dr. Philipson has recorded another illustration of the same character (*ib.*, 1865). Later, Sir B. W. Richardson wrote to point out distinctive signs of the separation of fibrinous coagula in the large thoracic vessels—*e.g.*, dyspnœa with open air-passages, fulness of the jugular veins, feeble pulse with tumultuous action of the heart, and weakened first sound: for such conditions he strongly advised the persistent administration of ammonia, not so much as a stimulant, but as a solvent of blood-clot, and preventive of putrefaction (Lancet, i., 1875). I cannot, however, adopt so sanguine a view of this medication.

Pyrexia.—In acute pyrexial and inflammatory conditions, solutions of acetate and citrate of ammonium relieve many of the symptoms by promoting secretion from the skin and kidneys.

Typhus and Typhoid Fever.—In adynamic stages of these fevers, ammonia has often been used, but not always with advantage; thus Stillé reports its failure, though largely given during an epidemic of typhus at Philadelphia. There is reason to believe that the amount of ammonia circulating in the blood is unduly increased in these maladies, and this would be a reason against using it: certainly its administration is very distasteful to the patients.

Scarlatina.—On the other hand, there is much clinical evidence of the value of ammonia in this fever. De Witt, Peart (1802), Wilkinson, and Strahl have written specially in its praise, and many illustrations of its value have been given by Hillier, Langdon Down, and others (Lancet, 1860-64-70; Med. Times, 1858-62-73, and Lond. Hosp. Reports, vol. i.). From 3 to 6 gr. of carbonate, freely diluted, are to be given every one or two hours, until improvement occurs: it determines to the skin, and perhaps thus hastens elimination of the poison. I have found it especially useful in cases accompanied by malignant sore throat. Dr. Down refers to 192 cases occurring in one epidemic at Earlswood asylum; 78 had severe angina, and 49 were malignant cases: all received 5 gr. of the carbonate every four hours, and were otherwise treated alike: alcoholic stimulants were used in moderation. Ten only, of whom seven were tuberculous, died;

and considering the low resisting power of imbeciles this result is good. He considered the remedy diminished febrile excitement and calmed the nervous system: it was taken readily without pain to the throat.

Dr. A. D. MacDonald gives benzoate of ammonium in scarlatina, on the principle that it is a powerful antiseptic, and finds it better than the internal administration of carbolic acid. The dose is 15 gr. for an adult every three or four hours, combined or not with liquor ammonii acetatis; the dose for children would be less. He relates cases of malignant scarlet fever successfully treated by this method (B. M. J., i., 1883.)

Ague.—Dr. D. Young has recorded cases in which patients intolerant of quinine are enabled to take it and experience its benefits when it is administered with 12 gr. of ammonium chloride to each grain of quinine sulphate. In many cases, however, he has found that salts of sodium or potassium will act as well in this direction as ammonium chloride (Pract., ii., 1883).

Chest Diseases.—In acute pneumonia, bronchitis and pleurisy, the acetate or citrate of ammonium is often serviceable. In asthenic cases, the later chronic conditions of bronchitis, and in senile catarrh, the carbonate and liquor are good stimulant expectorants; being eliminated in part by the pulmonary membrane; they modify its condition and thin the secretion. Ammonium chloride is also valuable in such conditions, and in asthenic cases of congestion of the lungs: it may at first increase pyrexia, but generally facilitates the expectoration, “softens the cough,” and improves the appetite. Dr. Patton commends the carbonate in acute pneumonia, and the chloride in later stages (Pract., vol. vi.).

In the bronchitis of measles, and of rachitis, ammonia is commonly and advantageously used—Sir W. Jenner, indeed, speaks of it as *the* remedy in the pulmonary affections of the latter malady, which are generally asthenic and tend to collapse (Med. Times, i., 1860). On the other hand, Dr. Eustace Smith maintains that if too early given to children with bronchitis, especially the capillary form, it may determine even a fatal issue by increasing congestion and irritation of the mucous membrane.

Croup.—In the later stages, when the membrane is more or less loosened and secretion free, and perhaps capillary bronchitis

is present, carbonate of ammonia may prove a useful stimulant, expectorant or emetic.

Pertussis.—I have seen relief given to the cough in later stages by inhalation of ammonia vapour, and Mr. Grantham has devised a simple method of effecting this by adding 1 oz. of the liquor to 1 gallon of boiling water in a bucket or bath, and then putting in a red-hot brick (*B. M. J.*, ii., 1871). The atmosphere of gas-works has often relieved chronic cases, a good effect which has been traced to the volatile sulphide of ammonium.

Bronchial Catarrh.—Hoarseness.—The chloride of ammonium in vapour deserves trial in obstinate cases of this kind, and Dr. H. Beigel introduced an arrangement of three bottles, one containing liquor ammoniæ, another hydrochloric acid, and a third a “wash-bottle” with water, through which air impregnated with the vapour was drawn for inhalation (*Lancet*, ii., 1867). Liebermann suggested another form of apparatus (*Bull. de Thérap.*, 1873), and several others are now obtainable: Burton’s is one of the best.

The bromide is of service in capillary bronchitis (Bartholow), in pertussis, and other spasmodic coughs. The chloride in lozenge (gr. ii. in each) and vapour has also been advised for hoarseness and granular sore throat, but the stimulus sometimes aggravates the symptoms at first.

Nerve Diseases.—Migraine.—The acetate of ammonium in 1- to 2-dr. doses will often relieve sick-headache. The chloride, in 10- to 20-gr. doses, is indicated in bilious and nervous forms occurring in the young, and in delicate, overworked women. In headache connected with menorrhagia it is said to be more useful than in that connected with irregular or suppressed menstruation (*Barallier, Bull. de Thérap.*, 1859).

Neuralgia.—In neuralgia, the chloride is often of great value, as Dr. Clifford Allbutt states after observation of fifty cases (*Med.-Chir. Rev.*, Jan., 1872): it is, however, very nauseous to some patients. (It may be well given with liquid extract of liquorice.)

In tic-douloureux, or facial neuralgia, especially if there be a marked rheumatic element and the lower jaw be affected, $\frac{1}{2}$ -dr. doses of chloride should be given at short intervals, for four doses: relief will probably have then set in if this remedy is going to benefit (*Watson, Lectures*, vol. i.). In cases ac-

accompanied with heat and swelling, Brenchley recorded marked relief to pain, and lowering of temperature under this treatment (Ranking, ii., 1858).

In *hemicrania* from nervous-exhaustion it is often curative (Med. Times, i., 1875), and in *sciatica* I have found either the carbonate or chloride valuable more or less permanently, if the pain is worst when the patient is in the standing or sitting posture. In the *intercostal* neuralgia of anæmic or suckling women, in *hepatalgia*, and in *ovarian* neuralgia, Dr. Anstie also reported much benefit from the chloride; and of the latter malady Dr. W. Curran has reported six severe cases marked by acute pain, pyrexia, vomiting, etc., occurring mostly at a period, and accompanied with fulness over the region of the ovary, all much relieved by the chloride in 15-gr. doses, which were given, however, with 5 min. of aconite (Ranking, ii., 1868).

Myalgia.—For this variety of pain, Dr. Anstie affirms “nothing in the whole list of remedies comes near the chloride in efficiency.”

Dysmenorrhœa.—The acetate of ammonium will often relieve the pain of congestive dysmenorrhœa. I have frequently prescribed it with success, especially if there be a sub-inflammatory or turgescient state of the mucous membrane, or when suppression has occurred from cold, shock, or fatigue (B. M. J., i., 1878).

Uterine Disorder, etc.—The chloride has often produced good results in amenorrhœa (Cholmeley, Practitioner, vol. ii.), and Dr. Anstie advised it in cases marked by general feebleness rather than by anæmia.

Hysteria.—Ammonia relieves several of the symptoms of this disorder, such as the lassitude and tendency to fainting, and the flatulent distension of the stomach. The aromatic spirit is a good preparation in common use. The liquor with asafoetida or valerian is effective, but nauseous; it has some power in staying convulsive attacks of presumably hysterical character.

Dyspepsia.—Acidity, etc.—In cases where flatulence with acidity are marked symptoms, ammonia will relieve by its alkalinity and by stimulating the stomach to contract and expel flatus; it is usefully combined with other remedies—the carbonate or aromatic spirit with soda or bitters. The chloride with hydrochloric acid relieves in some cases when the tongue is furred and

the biliary secretion deficient (B. M. J., i., 1875). For gastric and intestinal catarrh, also, it is commonly given in Germany.

Gout.—Dr. P. Heron Watson has found liquor ammoniæ fortior in doses of 10 to 15 min. in a tumbler of water three times daily, a most effective remedy in gout. Chloride of ammonium in full doses is often useful.

Hepatic Disorders.—In various forms of hepatic disorder accompanied with congestion, ammonium chloride is a valuable remedy. Dr. Murchison recommended it in “functional liver-disorder” accompanied with lithæmia, and Dr. Anstie in suppression of biliary secretion consequent on nervous shock. It is much used abroad in catarrh of the bile-ducts, and in the jaundice dependent on this condition; also in hepatic dropsy; but perhaps its best effects are seen in passive hepatic congestion when there is deficient intestinal secretion with loaded urine, constipation, coated tongue, and general “bilious” condition. As already stated, the chloride stimulates a due secretion of bile, increases the excretion of urea and the formation of glycogen. Dr. W. Stewart has especially drawn attention to the value of this remedy in *hepatitis*, and even *hepatic abscess*, and has found it act better in acute than in chronic stages of these maladies. If the skin be dry he orders first the acetate of ammonium and afterwards 20 gr. of the chloride every four or six hours: a feeling of warmth and exhilaration is produced, hepatic pain is quickly and markedly relieved, perspiration and urine are freely secreted, and sleep commonly follows (Lancet, 1870; B. M. J., ii., 1878; Treatise, 1879).

In *acute tropical dysentery*, drachm doses every four hours are said to act well, blood ceasing to appear in the stools on the third or fourth day (v. B. M. J., i., 1898); Dr. Stewart has corroborated this experience, tracing the effect to special relief of hepatic congestion: in some cases it is better combined with full doses of ipecacuanha (*ib.*, ii., 1898).

Hæmorrhage.—In hæmorrhage of different kinds, usually passive in character, the chloride was praised by Copland, who gave it with hydrochloric acid. It is not much used, but Warburton Begbie found good results from doses of 20 gr. in hæmaturia: in the illustrative case recorded by him there was no definite cause for the malady (Lancet, ii., 1875).

Diabetes.—Barlow, Golding-Bird and Bouchardat specially valued the carbonate in *diabetes*, as being a stimulant and a

nitrogenous substance (Guy's Reports, vol. v., etc.). Basham recommended the phosphate to be given with the carbonate and lemon-juice (B. M. J., i., 1869). Prout also thought the citrate serviceable, but rather as a diaphoretic than as possessing specific powers. The sulphide has been recommended to lessen morbid appetite, but it does not diminish the excretion of sugar (Garrod), and ammoniacal salts have not retained their reputation in this malady. Adamkiewicz has published certain facts which relate to the action of ammonium chloride in healthy and diabetic persons (Virchow's Archiv, Bd. 76, 1879). He states that in healthy persons (1) the salt is decomposed in the intestine, the ammonia is reabsorbed and appears in the urine as urea (*cf.* p. 383); (2) it acts like sodium chloride in being dehydrated in the tissues and favouring the decomposition of albumin. In diabetes he finds (1) ammonia is quickly metabolised and its assimilation coincides with the metabolism of sugar, so that in slight cases the sugar may disappear from the urine during its administration; (2) so long as the sugar is not completely metabolised, the urea and water do not increase, but as soon as the sugar disappears, the urea and water begin to increase in amount.

In **Vesical Catarrh and Prostatitis**, the chloride has proved useful, and in a case of irritable bladder, with pale urine of low specific gravity, and deficient in urea, much relief was apparently given by the citrate; the excretion of urea was at once increased under its use (Med. Times, ii., 1863). The benzoate of ammonium is valuable in chronic catarrhal cystitis, with phosphatic deposit; also in scarlatinal dropsy (Lancet, ii., 1861; Med. Times, 1864).

PREPARATIONS AND DOSE.—*Liquor ammoniæ fortis*: dose, 3 to 5 min., well diluted. *Liquor ammoniæ*: dose, 10 to 20 min., well diluted. *Spiritus ammoniæ fetidus*: dose, 20 to 40 min. *Ammonii carbonas*: dose, 3 to 10 gr. or more as a stimulant; 20 gr. as an emetic. *Spiritus ammoniæ aromaticus* (sal-volatile): dose, 20 to 40 min. *Ammonii chloridum* (sal-ammoniac): dose, 5 to 20 gr. or more. *Ammonii bromidum*: dose, 5 to 30 gr. *Liquor ammonii acetatis* (spirit of Mindererus): dose, 2 to 6 dr. diluted freely. *Liquor ammonii citratis*: dose, 2 to 6 dr. *Ammonii benzoas*: dose, 5 to 15 gr. *Ammonii phosphas*: dose, 5 to 20 gr. freely diluted. *Linimentum ammoniæ* (with olive and almond oils), for external use. *Linimentum camphoræ ammoniatum*, *Linimentum hydrargyri* (v. Mercury). *Tinctura guaiaci ammoniata*: dose, $\frac{1}{2}$ to 1 fl. dr. *Tinctura ergotæ ammoniata*: dose, $\frac{1}{2}$ to 1 dr. *Tinctura opii ammoniata*: dose, $\frac{1}{2}$ to 1 fl. dr. *Tinctura quininæ ammoniata*: dose, $\frac{1}{2}$ to 1 fl. dr.

METALLIC PREPARATIONS.

ALUMINIUM, $\text{Al} = 27.5$ (26.90).

THIS metal has not been found native, but *alumina*, its oxide, Al_2O_3 (known also as argillaceous earth), is widely diffused as a silicate in clay, slate, granite, etc., and occurs nearly pure in the sapphire and ruby. The metal itself is of steel-grey colour and is not readily oxidised: specific gravity, 2.67. Aluminium, owing to its lightness, has been proposed as a material for surgical instruments, for cooking and drinking vessels for military use. Experiments carried out for the German army authorities have shown however that it is unsuitable, as it is readily acted on by coffee, carbolic acid, salicylic acid, wines, and even pure alcohol (B. M. J., i., 1892). Later reports on this subject are more favourable—as from Madagascar (B. M. J., i., 1896), but the vessels cannot be repaired by solder. For probes, etc., it is good, but the metal forms an amalgam with mercurial salts (Lancet, ii., 1896).

Alumen, the official *alum*, is either the double sulphate of aluminium and ammonium, or of aluminium and potassium; in each case the salt contains a large amount of water of crystallisation. The formula for potassium alum is $\text{Al}_2 3\text{SO}_4 \text{K}_2\text{SO}_4 24\text{H}_2\text{O}$; and that for ammonium alum is $\text{Al}_2 3\text{SO}_4 (\text{NH}_4)_2 \text{SO}_4 24\text{H}_2\text{O}$. It occurs native sometimes in mineral waters, and in efflorescence on stone. (There are many similar “alums,” or double sulphates of an alkaline base and a metal, as sodium-alum, etc.; the same name is applied even when no alumina is present, as to the double sulphate of iron and ammonia—iron-alum—and to similar compounds of manganese and chromium.)

CHARACTERS AND TESTS.—Alum crystallises in regular octahedral sometimes in cubical forms, but is generally met with in irregular lumps, translucent and colourless when fresh, efflorescent and covered with small crystals after exposure. It has an acid reaction and a strongly astringent, subacid taste; it is insoluble in alcohol, soluble in about ten parts of cold, and half its weight of boiling water. Heated, it dissolves in its water of crystallisation, and when this has been driven off, potassium alum remains

as a dry, white, spongy mass (*alumen exsiccatum* vel *ustum*—dried, or burnt alum). This has very astringent, somewhat caustic properties; it readily absorbs moisture, but is sparingly soluble: heated beyond 400° F. it is decomposed, and alumina, the oxide, Al_2O_3 , remains. This oxide is insoluble in water, and when alum solutions are decomposed, separates as a precipitate; hence the use of alum for clearing turbid water, for when it is added, the alkaline and earthy salts present in the water combine with the sulphuric acid of the alum, and the alumina which is precipitated carries with it most of the impurities present: it has also disinfecting powers. 1. Ammonium sulphide, when added to solution of the salts of aluminium, gives a white gelatinous precipitate of hydrated oxide. 2. The caustic alkalies and their carbonates give a white precipitate with aluminium salts, soluble in excess of the former. 3. Solutions of aluminium salts should not give a blue colour on the addition of ferrocyanide and ferricyanide of potassium, showing freedom from iron. 4. Ammonia-alum, when heated with caustic soda or potash, evolves ammonia.

The *acetate* of aluminium (*argilla acetica*), the *chloride* (*aluminium chloridum*), and the *single sulphate* (*argilla sulphurica*), though not official, are in occasional use; they are all soluble salts, of characteristic styptic taste. The *chloride* is a white, amorphous, deliquescent powder. The *sulphate* has been found native, though not quite pure; it is more acid than the ordinary double sulphate, so that it blunts steel instruments, and corrodes linen. *Alumnol* is a combination of alum with naphthol-sulphonic acid, and is a fine whitish or yellowish-grey powder, soluble in water, glycerin and alcohol, but insoluble in ether: it contains 15 per cent. sulphur and 5 per cent. aluminium; it is odourless, antiseptic and astringent. *Sozal*, an aluminium salt of paraphenol-sulphonic acid, is an antiseptic, astringent, soluble powder; there are also a salicylate, a gallate, and a tannate of aluminium.

ABSORPTION AND ELIMINATION.—Taken into the mouth, alum exerts the local action presently to be described, and its first sweetish taste is followed by a feeling of constriction, and an abundant flow of saliva: after reaching the stomach, combined with albumin some of it becomes absorbed, though slowly. Orfila detected it in the urine and viscera of dogs after large doses (*Annales d'Hygiène*, i.), and Krauss found the urine become very acid under its use. The greater part of the alum taken combines to form insoluble compounds with the bile and other organic products, and is eliminated with the *fæces*. Siem, after injecting,

in animals, a double lactate which caused poisonous symptoms, found the metal in the urine, but Kimkel failed to do so after giving the drug by the mouth (Handb. Toxikologie, 1899). It is remarkable that although alumina is so common a constituent of vegetable food, it is not found in the human organism, showing how completely it passes out.

PHYSIOLOGICAL ACTION.—*External.*—Alum acts as a typical simple astringent, contracting the arterioles and muscular fibres of the part touched by it, and rendering the surface pale and dry. It combines with albumin in the secretions, forming whitish flakes or membranous films insoluble in water, but soluble in acetic and hydrochloric acids (Mitscherlich). If there be not enough fluid present to saturate the alum, it affects the deeper tissues in a somewhat caustic manner: this is especially the case with the dried salt. Strong or long-continued applications excite irritation with some degree of inflammation, and under such circumstances, discharge from an affected part—*e.g.*, the conjunctiva, or the vaginal mucous membrane—may be increased rather than diminished.

The *acetate of aluminium* and *chlor-aluminium* have marked disinfectant powers, preserving organic tissue, and hindering putrefaction. Burow (1857) found that the acetate, mixed with fresh blood, formed a brown syrupy mass, in which the shape of the corpuscles was not retained, but which remained without decomposing for many months; 0.5 per cent. prevented putrefaction of urine and of meat, and 2 per cent. sterilised bacteria. The liquor aluminii acetici, P. G., contains about 8 per cent. of the salt, and experiments in antisepsis have been made again with it as compared with the aceto-tartrate recently introduced under the name of "Alsol." The former destroyed spores of anthrax in two hours, the latter in 5 per cent. solution in ten hours, while carbolic acid, 5 per cent., had no effect: on pus-forming cocci, however, and tubercle bacilli the acid was more destructive than the acetate, but alsol was more effective than either (B. M. J., Dec., 1900). (Among the minor uses of the acetate it may be mentioned that Mr. Chieux has employed a solution of that salt to render cloth waterproof; steeping the cloth in the solution for a few minutes is all that is necessary.)

The *chloride of aluminium*, chlor-alum, was introduced (mainly

by Mr. John Gamgee) as a disinfectant free from poisonous or corrosive properties ; it not only prevents decomposition, but removes its products by absorbing gas, etc. : it serves best, perhaps, for the disinfection of closets, drains, etc. : in the dissection room it is useful, but locally applied renders the muscular tissue pale (Lond. Med. Times, 1873).

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—Small doses (3 gr.) taken several times daily, in water, cause dryness of the mouth and throat, thirst, and diminished secretion in the alimentary canal, the stools being rendered harder and less coloured than normal. Doses of 10 gr. disorder the digestion by lessening the gastric secretion, and from 15 to 60 gr. cause cramping pain and nausea : 2 to 3 dr. induce vomiting without much straining, and larger continued doses may cause colic and diarrhœa with considerable *increase* of secretion from the intestinal mucous membrane.

In *rabbits*—which do not vomit—2 dr. proved fatal, with evidence of inflammation and erosion of the stomach (Mitscherlich). To *dogs*, Orfila gave 1 to 2 oz. without other marked effect than vomiting, though if a ligature were passed round the œsophagus, 1 oz. would cause death in a few hours (Devergie). In these cases the gastric membrane was found to be either white and wrinkled, almost tanned, or was distinctly inflamed in patches.

Devergie concluded from his experiments that the human was more sensitive than the canine stomach, and certainly large doses of 1 to 2 oz. cause in man much burning pain, frothing at the mouth, vomiting, purging, and depression : the symptoms of gastro-enteritis may develop themselves, but usually the emetic action gets rid of the drug before serious injury is produced. The results vary somewhat with the condition of the stomach at the time, for at a trial in Paris it was proved that a lady, the subject of chronic dyspepsia, took about 20 gr. of burnt alum (by mistake for gum arabic), and suffered from enteritis in consequence. Orfila gave evidence that such a result was due to exceptional causes, and that 4 to 6 dr. were often given without inconvenience. Death has been reported in a man aged fifty-seven from taking 13 dr. of burnt alum : he suffered from a sensation of burning and constriction, general malaise and anguish, hurried

respiration, and nausea with sanguineous vomiting : intelligence remained good (Union Méd., No. 64, 1873).

Alum was at one time largely used in the adulteration of bread, for it gives a whiter colour to the flour. Injurious effects, such as dyspepsia and constipation, have been attributed to it, and though Christison failed to notice bad results from any amount that came under his notice, I have myself often traced indigestion to alum in the bread : it would certainly follow the use of any large quantity. Mallet found that in the United States most baking powders contained alum, and that in such doses as may be derived from eating bread, gastric digestion was considerably interfered with ; therefore, the use of alum in baking should be strictly avoided (B. M. J., i., 1889 ; i., 1893). (It may be noted that ordinary natural wheat flour would give about 4 gr. of silicate of alumina to the 4-lb. loaf, and the determination of the amount of added alum has been a frequent puzzle to analysts (Med. Times, ii., 1875).)

Synergists.—Tannin, sulphuric acid, and astringents generally, favour the action of alum and are often combined with it ; but as tannin decomposes alum, if given in the same mixture or compound, the substances really prove less astringent than when given separately.

ANTAGONISTS.—INCOMPATIBLES.—If an overdose of alum be taken, mucilaginous and albuminous liquids such as milk with white of egg, or gum arabic, or fluid glue, should be freely given. Magnesia should be added according to Von Hasselt, or carbonate of ammonium in small quantities (Taylor). Alkalies and their carbonates, and acetate of lead, are chemically incompatible with alum.

THERAPEUTICAL ACTION.—External.—Alum is one of the oldest known remedies, and was often prescribed by Hippocrates and Celsus ; its properties render it unsuitable for the acute stages of any active inflammation, but most useful in many chronic catarrhal conditions, and relaxed states of mucous membranes.

Skin Diseases, etc.—In some forms of discharging skin disease, such as chronic eczema, an alum lotion of moderate strength (1 dr. to 6 or 8 oz.) will act favourably as an astringent ; it is also useful if sponged over the surface in profuse and exhausting perspirations. On indolent sores and fungous granulations the powder may be sprinkled, opium being added, if desirable to

lessen the pain that may be caused; this combination, added to catechu, has also been praised in hospital gangrene. The "lapis divinus," which is prepared with equal parts of alum. blue-stone, and nitre, fused together, is a stimulant application to ulcerated and discharging surfaces, much used on the Continent, and compounds of aluminium have lately proved very serviceable as disinfectant and alterative dressings.

The acetate of aluminium, and the double sulphate of aluminium and zinc, have been specially recommended in lotion for foetid perspiration and ulceration; the former, in lotion or ointment ($2\frac{1}{2}$ to 5 per cent.), has also been much commended for subacute and even acute eczema, especially in Germany. Thorey prescribed the chloride for diphtheritic and gangrenous sores, though others report it unduly irritant; in the form of "liquor" it is still sometimes used as an antiseptic. Alumol is an antiseptic, moderately astringent dusting powder, useful in inflamed and pustular skin diseases (B. M. J., ii., 1892, Ep.); also in lotion or ointment 2 to 10 per cent. or upwards for gonorrhœa, erosions, etc., as well as in moist eczema, pharyngitis, and other acute superficial inflammations (Edin. Journ., Dec., 1896). The silicate (Fuller's earth) is in constant use for intertrigo.

Stomatitis.—When small ulcerations occur in the buccal mucous membrane, in gingivitis and in aphthous conditions, dried alum in powder, or a lotion combining it with myrrh and spirits of wine, is very useful. Salivation is also restrained by its moderate use, and injurious effects on the gums during a mercurial course may be prevented by keeping a piece of alum in the mouth for a few minutes occasionally. At Aix-la-Chapelle patients are ordered to use alum gargles and washes frequently during the mercurial treatment; they are, however, acid, and apt to attack exposed dentine. The liquor aluminii acetici is used in the dilution of 1 to 3 of aqua aurantii floris as a mouth wash, and 1 to 2 of water as an antiseptic lotion.

Toothache dependent on caries may often be cured by the local use of a paste made with alum, ether, and mucilage, which should be applied until the sensitive nerve is destroyed (Legaulon).

In **Catarrhal Angina** and "relaxed throat," especially for relaxed uvula, the gargle of Rivière (1 dr. of alum to 6 oz. of water) is still a frequent prescription.

In **Hoarseness**, a gargle containing 2 dr. of alum in 6 oz. of barley water has been found useful for professional singers (Bennati) : the remedy is still better applied in the form of spray (10 gr. to 1 oz.).

Tonsillitis.—Pharyngitis.—In early stages even of acute tonsillitis, insufflation of finely powdered alum, or warm weak alum gargles will often assist in cutting short the attack, but if this be fully developed before treatment is commenced, alum would be more likely to irritate than to relieve : its use is better reserved for chronic congested conditions, with or without spots of ulceration, when the fine powder should be gently blown over the affected part through a quill or suitable tube.

The *glycerinum aluminis* (1 part of alum to 5 of glycerin) acts as a powerful local astringent, especially in cases of chronic pharyngitis ; it is less disagreeable than tannin. This same preparation may be diluted, and then forms a convenient lotion, gargle, or injection.

In **Purulent Ophthalmia**, as occurring especially in children, an alum lotion containing 4 to 6 gr. to the ounce was formerly much used. Mr. Tweedy has pointed out that this remedy is a dangerous one ; for if there is abrasion of the conjunctiva the alum penetrates to the cornea, and by dissolving the cement between the corneal fibres produces perforation. Alum, in fact, is a reagent employed by histologists to separate the corneal elements. On account of the difficulty in perceiving minute abrasions, he thinks it is safer never to use alum lotion in any case of eye-disease (Pract., ii., 1883) ; but practically it has been found effective.

In **Gonorrhœal Ophthalmia**, and in the severe ophthalmiæ of Egypt and India, similar frequent use of alum lotions is also serviceable. I have seen cases cured by applying round the orbit a mixture of burnt alum with lemon-juice.

In **Catarrhal Conjunctivitis** and **Chemosis**, a convenient and useful application is the alum curd, made with boiling milk, or the alum "poultice," prepared by rubbing a little of the powder with white of egg till a coagulum is formed ; this is placed between two layers of thin cambric and applied over the closed lids.

Otorrhœa.—Ozæna.—In subacute or chronic stages of

otorrhœa, an alum injection of the strength already mentioned—4 to 6 gr. to the ounce—is cheap, and often effective; its use should be preceded by a douche of plain water, otherwise the alum will be prevented by coagulated secretion from directly reaching the affected membrane. The remedy should not be continued too long, or it may excite irritation.

In chronic ozæna (offensive nasal discharges), a douche of double or treble strength may be cautiously used. Homolle has recommended the *single sulphate* as a better remedy for this disorder, and others have preferred the chloride (chloralum) or acetate.

Nasal Polypi have sometimes been cured or greatly relieved by the insufflation of finely powdered alum, or strong alum solution.

Leucorrhœa.—Gonorrhœa.—Injections of alum alone, or combined with zinc, benzoin, or oak-bark, are often used with advantage, especially in leucorrhœal discharges: a strength of about 5 gr. to the ounce is usually sufficient, and plain water should be first injected to cleanse the surface. In the early acute stages, as already mentioned, alum is not suitable, and at any time too strong a solution applied to the vagina may cause irritation and cramping pain.

Prolapsus.—Leucorrhœa is commonly accompanied by a relaxed condition of the vaginal mucous membrane, which is also amenable to alum. A good method of using it is to place a sponge, soaked in its solution, well within the vagina for several hours; this will often relieve the slighter forms of prolapsus uteri. Dr. R. Bell recommends tampons medicated with glycerin and alum; the astringent action and subsequent benefit, especially in cases of flexion, are attributed by him both to the alum and the glycerin (Lancet, i., 1884). Rectal prolapsus should be bathed with alum water before being returned, and afterwards an injection of the same should be practised.

The severe **Pruritus** and burning about the vulva and the anus, often associated with leucorrhœa and prolapsus, may be equally relieved by strong alum solutions.

In the **Vulvitis** of children, alum is one of the best remedies, a solution of 1 dr. to the pint of water being applied constantly and injected occasionally.

Chronic Catarrhal Cystitis, etc.—This obstinate disorder

may be often relieved by the use of a weak alum injection—10 gr. in the pint: the bladder should be first washed out with warm water, so as to avoid the clotting of discharge.

I have known vesical pain and frequency of micturition and also hæmorrhage from the mucous membrane of the bladder or urethra quickly relieved by such or stronger injections, which have been followed also, in several instances, by marked diminution of the thick, ropy mucus commonly secreted in this malady: the alkaline reaction and acrid ammoniacal odour of the urine have been removed at the same time. The last-named conditions may be dependent sometimes on the introduction of low organisms by a soiled catheter, but even in such cases alum-injections are equally useful by their antiseptic properties. Blockley and Parkington especially recommended the single sulphate for vesical and vaginal catarrh.

Hæmorrhage.—Epistaxis, etc.—Alum is serviceable applied externally in cases of bleeding from superficial vessels, as from surface wounds or mucous membranes, *e.g.*, of the nose or vagina, from hæmorrhoids, leech-bites, or after extraction of teeth: in such cases it may be used in substance, a pointed plug or the fine powder being firmly placed on the part, or a compress steeped in a strong warm solution may be allowed to cool upon it. Such applications contract the vessels, but it should be borne in mind that if too strong or too prolonged they may give rise to ulceration. The alum powder is sometimes combined with zinc sulphate, or diluted with starch or sugar, and the solution may be made with decoction of logwood. Combined with benzoin and alcohol it forms a celebrated styptic and antiseptic, the “Aqua Pagliari” (benzoin, 100 gr.; alcohol, $\frac{1}{2}$ oz.; dissolve and add water, $\frac{1}{2}$ pint; alum, 1 oz.; boil till clear, then filter). The solution of Mentel and that of the U.S. Dispensatory is similar, but made with the single sulphate: 2 to 4 dr. of these in a pint of water make a useful astringent lotion or injection.

THERAPEUTICAL ACTION.—*Internal.*—The internal use of alum is combined with its external application in many varieties of hæmorrhages, though it is not depended upon so much now as formerly: it is best suited for cases of “passive hæmorrhage,” dependent on the relaxed condition of a mucous membrane, and when no acute inflammation is present.

In **Hæmoptysis**, when moderate but persistent, it has been held to be a good adjuvant to other remedies, *e.g.*, sulphuric acid. Skoda commonly gave 10-gr. doses with Dover's powder. A spray containing the same quantity in 1 oz. of water has been recommended.

In **Hæmorrhage from the Stomach or Bowels**, especially when dependent upon cirrhosis of the liver, and when passive and atonic in character, alum may be a suitable remedy; its astringent effect in such cases is, in part at least, direct and local.

In **Menorrhagia** Cullen especially commended alum, and it is still used more frequently perhaps in this flux than in any other. In the form of "alum whey," which is prepared by boiling 2 dr. of the powder with 1 pint of milk, straining off the curd and adding sugar, it is a not unpleasant medicine, of which a wineglassful, three or four times daily, will generally control the discharge.

Hæmaturia.—In bleeding from the kidneys, alum whey has also been used, but "iron alum" (double sulphate of iron and ammonia) is a still more active remedy, which has, in my experience, acted better than many others. The same whey has been found useful in other chronic discharges, such as diarrhoea, and bronchorrhoea. In five cases of chronic hæmaturia recovery ultimately occurred under 20-gr. doses of alum, given three times a day, *largely diluted*—these doses did not constipate (*Pract.*, ii., 1889).

Albuminuria.—The drain of albumin in Bright's disease is practically equivalent to a loss by hæmorrhage, and it has been sometimes restrained by the use of alum: thus Oppolzer and Heller have reported benefit from it in chronic cases, but after repeated trials I have not been able to verify their good results.

Diabetes.—In diabetes insipidus, or "polyuria," when there is an excessive flow of limpid non-saccharine urine, alum deserves further trial, though the malady is anomalous and often is uncontrolled by any remedies. In true diabetes a partial and temporary benefit has been derived by some patients for whom I have prescribed it.

Gastric Catarrh.—In cases with vomiting of glairy mucus, alum is a cheap and efficient remedy. Sir J. Murray, one of the principal advocates for its use, pointed out that it acted better

when given in substance than in solution : thus a pill with gentian extract is a good form, or an electuary with honey.

Diarrhœa.—I have found alum very useful in infantile diarrhœa when arising from errors in diet, and attended with vomiting, acidity, and green stools : from 1 to 5 gr. may be given with syrup. Diarrhœa dependent upon relaxed conditions of the intestinal mucous membrane is also cured by alum. Fouquier and others have praised it in enteric fever (*Bull. de Thérap.*, ix.), but it is not easily taken, and it is liable to irritate, so that other remedies are usually to be preferred. Alumina, or argilla pura, is placed in the Austrian Pharmacopœia as an antacid remedy for diarrhœa, especially in children, and is used like bismuth salts. Barthez recommends the single sulphate.

Dysentery.—Moseley, in his work on tropical diseases, considers alum to be one of the best medicines in acute and chronic dysentery, and Dr. Waring has often seen it useful in asthenic cases ; it was commonly given with opium. I think that a good mode of administering it in chronic cases is by enema, from 10 gr. to 2 dr. in a pint of liquid being used at a time (*Hannon, Bull. de l'Acad.*, xxxii.); this will also relieve the troublesome tenesmus, and the sense of itching and excoriation about the anus. One drachm to the pint is a proportion I have commonly used twice daily with good success ; a strength of $\frac{1}{2}$ oz. to the pint has also been used, but caused some burning pain ; improvement, however, soon began, and cure resulted after about fourteen days of treatment (*Med. Record*, 1879). Dr. Hepburn found good result from this strength in an acute case (*Lancet*, ii., 1889), and a chronic case recovered well with it after failure of many remedies by the mouth (*ib.*, i., 1901).

Constipation.—Besides the astringent power exerted by 5- to 10-gr. doses of alum, we must notice the irritant effect of larger quantities, by which probably they become useful in constipation. Alum is seldom to be preferred to other remedies for this disorder, though it may act favourably in atonic cases, when the muscular coat of the bowel is deficient in power, and when intestinal secretion is scanty. Mr. Aldridge has published reports illustrating the good effect of 20 to 40 gr. daily in producing copious and solid evacuations ; he also associated it with sulphate of magnesia (*Braithwaite*, vol. xii.). Such treatment, however, is rarely worth

trial, and my own experience with it is not favourable; it either increased constipation or caused dysenteric symptoms.

Lead Colic.—In this malady, accompanied as it is by obstinate constipation, there is much evidence of the virtue of alum, dating from the last century. Dr. Copland praises it, and M. Brachet, of Lyons, writing from a large experience, awards to it the first place amongst remedies; for eight years he states that the treatment he employed consisted of emetics and purgatives, then he gave a trial to antiphlogistics, and then to opiates: lastly, influenced by the success of Gendrin, he commenced to give $1\frac{1}{2}$ to 2 dr. of alum daily in mucilaginous liquid, and either with or without laudanum; on the third day usually the bowels acted, and if not, an aperient was given and the patient was nearly or quite cured, and this in upwards of 150 cases. The successful cases of M. Gendrin were fifty-eight in number, and he experienced no failures with the alum treatment.

The intestines have been generally regarded as the seat of disease in lead-poisoning, either in all their structure or in their mucous or their muscular coat. Méral especially argues that the latter is in a state of paralysis, a conclusion which has been widely accepted, and alum has been supposed to act partly as a stimulant to the paralysed muscle, and partly as a direct chemical antidote to the lead which it converts into an insoluble sulphate. In support of this view it may be mentioned that other sulphates, as of magnesium, sodium, zincum, and free sulphuric acid also act favourably, but it scarcely explains the quick relief that is sometimes given. It would seem to have a specific power of relieving pain, because it has proved useful in other varieties of gastralgia and colic.

I have only witnessed the good effects of the drug in two cases of lead-poisoning which presented all the usual symptoms: it relieved the pain and terminated the constipation; from 10 to 20 gr. may be given every two hours, properly diluted, and this quantity may be increased to 1 dr. or more, if necessary. Sulphuric acid and syrup of lemon form a suitable vehicle for it: in some cases it is well combined with a little opium. On the other hand, several good authorities report less favourably of the remedy: Tanquerel and Grisolle found it almost inert, and Brown records increase of pain and of constipation from its use. Huse-

mann, who may be taken as representing the German school, speaks of it as "obsolete," but with us it certainly is not so; Dr. Bartholow, for instance, in his recent treatise, describes it as "most effective" in the relief of the pain and vomiting.

In **locomotor ataxy** aluminium chloride is said to relieve the "lightning pains" (Gowers).

Ague.—The practice in Calcutta of giving grain doses of burnt alum in intermittent fever is described as successful in those cases in which the attack occurs with clock-like regularity; it failed in only 13 per cent. In cases in which the attacks come on irregularly, the remedy seems to be of no avail (*Med. Times*, i., 1882). Additional evidence, mainly Russian, has been furnished in favour of alum being a moderately good substitute for quinine, especially in quotidian recent ague—8 gr. were given three hours and again one hour before the expected attack: this was taken in powder and afterwards water was given freely. It is, however, an uncertain remedy and has been proved to have no effect on splenic enlargement.

Emetic Action—Diphtheria.—Besides its astringent and stimulating power, alum, in doses of about 1 dr., is a very useful emetic, because it is prompt in action, and does not depress the system: hence it has been recommended in diphtheria, both to dislodge the false membrane and hinder its re-formation; it may be repeated every quarter of an hour for several doses. Narcotic poisoning has also been treated by it.

Whooping-Cough.—In the chronic stages of this complaint, where secretion is profuse and spasm severe, and there is not much complicating bronchitis or pyrexia, I have seen alum exert a very beneficial influence: 4 to 10 gr. in water or syrup should be given three or four times daily. Dr. Golding-Bird introduced and highly commended this treatment, conjoining the alum with conium and dill-water. Dr. Meigs states that alum has given him, in sixty-eight cases, better results than any other remedy (*Diseases of Children*). Its good effect may be traced, partly, to a local astringent action on the fauces; hence it is best administered in some thick vehicle, and swallowed slowly; 2 gr. with syrup and cinchona is a good form for a child four years old, and may be commenced as the catarrhal stage is passing off.

Asthma.—Bronchitis.—It is said that a paroxysm of asthma

may sometimes be prevented by placing about 10 gr. of alum on the tongue. In bronchitis, 6 to 10 gr., given every four hours, serve to facilitate expectoration, and at the same time its amount is restrained and dyspnoea relieved. Moseley praised this use of alum many years ago, and advised it both for acute and chronic cases with viscid ropy expectoration; but it is in these latter cases only that I should consider it suitable.

PREPARATIONS AND DOSE.—*Alumen*: dose as an *astringent*, 5 to 10 gr.; as a *purgative*, 30 to 60 gr. or upwards; as an *emetic*, 1 dr. to 1 oz. In lead colic, 20 to 120 gr. have been given in the twenty-four hours. *Alumen exsiccatum*: the dose should be somewhat less, and practically this preparation should be kept for external use only. The *solid drug* seems to be more effectual than the liquid form; it may be given in pill or in confection with sugar, honey, or molasses: cream of tartar may be added, if necessary, to obviate constipation, and cinnamon or other aromatics to prevent flatulence. The "*Pills of Helvetius*," formerly celebrated, contained 3 gr. mixed with "dragon's blood"; a more modern formula is with gentian, rhubarb, etc.

In *solution* it may be given with sweetened aromatic water or mucilage, or sulphuric acid and syrup of lemons may be added; or an "alum whey" may be made by stirring 2 dr. of the powder with a pint of boiling milk, straining, and adding sugar.

For a *collyrium*, a strength of 5 gr. to the ounce of rose water is suitable: for a *gargle* from 8 to 20 gr. in the ounce: for a *lotion* or *injection* it may be well combined with zinc sulphate, as in the liq. aluminis co. (L.P.), which was ordered with 1 oz. of each salt to 3 pints hot water; for an *ointment*, 12 to 24 gr. to the ounce of simple ointment; for a *liniment*, with white of egg and camphorated spirit (for bed sore). The *glycerinum aluminis* (1 in 6 parts of water and glycerin) is the only official preparation. *Aluminii chloridum*: dose, 2 to 4 gr. (v. pp. 399-400).

Fuller's Earth is a native silicate of aluminium, containing traces of iron. *Prepared Kaolin* is a white form of the same, purified by elutriation. These are used as absorbent powders and being unacted upon by most chemical reagents, Kaolin especially is used as a pill basis for nitrate of silver and permanganates, etc. *Cimolite* is another name for the same silicate, further purified and perfumed.

ANTIMONIUM—ANTIMONY—STIBIUM,

$$\text{Sb} = 122 \text{ (119).}$$

This substance, which in certain of its chemical properties more resembles a non-metallic than a metallic element, occurs native, but in small quantities. It is usually found in alloy with various metals, chiefly iron, lead, and arsenic, and from these its purest commercial samples are seldom quite free. Traces of it occur also in some chalybeate waters, and its oxide constitutes the "white antimony ore" (valentinite): its most common ore is the sulphide, from which crude antimony is obtained by fusion with iron, or by roasting and reduction with charcoal.

When pure it is silvery white in colour with a tinge of blue, laminated in structure, brittle, and crystalline; it is heavy (sp. gr. 6·7) and permanent in the air at ordinary temperatures. In its chemical relations it is allied to nitrogen and phosphorus, and still more closely to arsenic.

COMPOUNDS OF ANTIMONY.

ANTIMONIUM NIGRUM PURIFICATUM—PURIFIED BLACK ANTIMONY ($\text{Sb}_2\text{S}_3 = 340$).

CHARACTERS AND TESTS.—A crystalline, steel-grey, metallic-looking powder, which dissolves in boiling hydrochloric acid, with evolution of sulphuretted hydrogen.

ANTIMONIUM SULPHURATUM—SULPHURATED ANTIMONY.

This substance is a mixture of sulphide and oxide of antimony, Sb_2S_3 and Sb_2O_3 . It is sometimes called the golden or precipitated sulphuret.

CHARACTERS AND TESTS.—An orange-red powder, inodorous, almost tasteless, insoluble in water, soluble in hydrochloric acid, also in solutions of caustic alkali, and of acid tartrate of potash: exposed to light and air it partially decomposes, with separation of sulphur. Sixty grains moistened and warmed with successive portions of nitric acid until red fumes cease to be evolved, then dried and heated to redness, give a white residue weighing about 40 gr.

There are several other reddish or brown oxy-sulphides of antimony, and all have been termed "kermes mineral" from some resemblance in colour to the insect kermes (cochineal).

ANTIMONII OXIDUM—OXIDE OF ANTIMONY ($\text{Sb}_2\text{O}_3 = 292$).

CHARACTERS AND TESTS.—It is a greyish-white powder, inodorous, tasteless, and insoluble in water, but readily soluble in hydrochloric acid: moderately heated it fuses and turns yellow, at a red heat it burns or sublimes in crystals. Its solution in hydrochloric acid when dropped into distilled water gives a white deposit, which is changed to orange by sulphuretted hydrogen.

ANTIMONIUM TARTARATUM—TARTARATED ANTIMONY—TARTRATE OF ANTIMONY AND POTASSIUM—TARTAR EMETIC
($\text{KSbOC}_4\text{H}_4\text{O}_6 = 343$).

CHARACTERS AND TESTS.—Occurs in rhombic, octahedral, colourless crystals, transparent when fresh, but efflorescing on exposure to air; also, and more frequently, in the form of powder, which should be perfectly white, a yellowish tinge indicating the presence of iron. It is odourless, but has a sweetish, subacid taste, which quickly becomes metallic and nauseous, but may not be much noticed if the powder be largely diluted. The crystals are best obtained for microscopic examination by evaporating on a slide a drop of the hot solution: characteristic triangular facets are seen, and some modifications of the cube, and they are larger than *arsenical* crystals: branched crystalline forms also occur, as in many other saline solutions. The crystals of tartar emetic are isomorphous with those of the *sulphate of potassium*, but the latter do not effloresce. Tartar emetic is soluble in 2 parts of boiling and in 14 parts of cold water; less soluble in proof spirit, or in wine, and insoluble in absolute alcohol. Acids, except tartaric acids, occasion a white precipitate, as also do alkalies, alkaline earths, and their carbonates, but excess of these agents will re-dissolve the precipitates.

The dried salt, like other tartrates, decrepitates and chars on the application of heat, and its solution in water readily becomes mouldy from the development of a fungus (a little added spirit will prevent this).

Infusion of galls, catechu, cinchona, strong tea, or tannin in any form, precipitates a tannate of antimony, which is so insoluble as to be practically inert. The following tests are applicable to any soluble antimonial salt: (1) If it be boiled in water with $\frac{1}{6}$ part of pure hydrochloric acid and a strip of metallic copper, antimony will be deposited on the metal, violet-red in colour if the quantity be small, but iron grey, or black, if in large amount. (2) A solution acidulated with the same acid ($\frac{1}{10}$ th) gives, in the cold, a black deposit on pure tin. (3) Sulphide of ammonium, or sulphuretted hydrogen, produces, in acid solutions, an orange-coloured deposit soluble in hydrochloric acid (boiling), and if this latter solution be poured into water, a white precipitate of oxide occurs. (4) Evolution of nascent hydrogen (as from zinc and sulphuric acid), in the presence of antimony, leads to the formation of *antimonuretted* hydrogen: this burns with a blue flame, and produces on porcelain a black stain which is insoluble in bleaching powder.

ABSORPTION AND ELIMINATION.—Soluble compounds of antimony, such as tartar emetic, are readily absorbed, especially by mucous membranes, and they circulate in the blood, either unchanged or as albuminates. The infant at the breast may be affected by them through the mother, and they may be detected in the different secretions during life, and in the viscera, especially the liver, kidneys, and intestines, after death.

The degree of absorption varies with the preparation used, the dose, and the state of the stomach. Metallic antimony in powder, the oxide, and the sulphuret are absorbed to some extent, but much less freely than the potassio-tartrate, which is itself more completely absorbed, and acts more powerfully, if acid wines or fruits are taken at the same time (Trousseau). Large doses are usually vomited soon, and before much absorption has occurred; but if taken with, or shortly after, food, vomiting is delayed, and a poisonous amount is more readily taken up into the circulation. This does not conflict with the statement made by Trousseau, that if a patient be living *well*, irritant effects, such as vomiting and purging, are more likely to occur from medicinal doses of antimony, whilst *spare diet* favours the production of constitutional effects, such as sedation and increased secretion, without so much gastric irritation. This fact has been explained by the presence of more chlorides in a full diet (as compared with a spare one), leading to the formation of more of the irritant chloride of antimony (Mialhe); but Bellini found that no such decomposition occurred with artificial gastric juice at the temperature of the body, and the hypothesis of Mialhe has not been accepted.

Salts of antimony combine with albumin, but in alkaline solutions form no precipitate; they do so in acid solutions, and have been said only to exert an irritant action on those parts of the body where they meet with an acid secretion, such as the stomach, and the orifices of the sweat glands (Brunton),—but this has been negatived (Stockman).

If the mucous membrane of the alimentary tract be inflamed, the irritant effects of antimony are proportionately severe.

Absorption may occur through the skin, though not readily whilst the epidermis is intact; after frictions with antimonial ointment, vomiting has occurred, and the drug has been found in the urine (Coze, Bull. de Thérap., 1869).

The vapour does not seem to be readily absorbed, since workers in it do not suffer constitutional effects (Oliver). The principal works in this country are on Tyneside, where the sulphide from Japan is smelted with iron filings, and the only trouble of the men is an herpetic or pustular skin rash, which is traceable more to heat and perspiration than to the fumes of the metal.

Antimony is *eliminated* by the kidneys, the skin, the mucous membrane of the bronchi, and mainly by that of the stomach and intestines. Orfila recorded its special determination to the lungs, and Millon to the liver (*Annales d'Hygiène*, vol. xxxvi.). An important fact is that elimination occurs by the intestinal tract, even when the drug has been given by the veins, the rectum, or any other channel (*Lancet*, i., 1856). The amount passed out by the kidneys, and probably by the other glands, varies at different times in the same individual, for Mayerhofer, whilst continuing to take the drug, found it only occasionally present in the urine (Heller's *Archiv*, 1846).

The time of its remaining in the system has been variously estimated. According to Taylor, it passes wholly from the stomach within a short time, and may then be found in the liver, the kidneys, and spleen, and in smaller quantities in the blood. After a few weeks, all traces have disappeared from these tissues, but some may be found in the fat and the bones; generally, elimination is complete in from twenty to twenty-five days, but according to Millon, the drug may be found in the liver and intestines four months after administration.

PHYSIOLOGICAL ACTION.—*External.*—The watery solution of tartar emetic applied to the skin acts as a slight irritant, producing redness, but the ointment when rubbed in acts more powerfully, causing inflammation, a papular eruption, and pustulation. The pustules produced by antimony are very painful; they are irregular in size and shape, but being often umbilicated, resemble those of variola: they mature about the fifth day, forming scabs; sometimes they slough and leave scars. Individuals vary much in susceptibility to the ointment, and during fever, or severe visceral inflammation, pustulation is not easily induced.

It has been stated that alkalis mixed with antimonial salves prevent their pustulating effect, and also, but incorrectly, that freshly blistered surfaces do not pustulate because of the alkalinity

of the serum; on the other hand, acids increase the effect. The irritation occurs at the mouths of the sweat and sebaceous glands, where the secretions are acid.

If concentrated solutions be taken by the mouth, they are liable to cause inflammation and even ulceration about the gums, fauces, and cesophagus, so that an "antimony sore throat" has been described, and its accompanying salivation and dysphagia may be very severe. Conditions much resembling those of diphtheria have also occurred (Med. Times, i., 1846), but are not often met with under the present more cautious use of the drug.

The prolonged contact of antimony determines in the intestinal mucous membrane local phlegmasiæ analogous to those already described as occurring in the skin; Trousseau verified this by *post-mortem* examinations.

PHYSIOLOGICAL ACTION.—*Internal.*—**Circulatory System.**—Under the influence of antimony, the blood is altered in its chemical characters (Richardson), but in a manner not yet well understood; it may become impoverished from destruction of red and increase of white corpuscles (Schmidt), just as under the action of arsenic (Koschlakoff): in cases of poisoning by the drug, it has been found more fluid and less coagulable than normal, the amount of fibrin being diminished.

A prominent symptom of the full action of antimony is *depression* of the circulation, both as to force and rapidity; but such depression is often preceded by a rise in the pulse rate, and a similar rise may occur before death in the later stages of poisoning.

Ackermann, experimenting upon healthy men with emetic doses (about $\frac{3}{4}$ gr. of the tartrate), found a *prolonged rise* in the pulse rate, to an average maximum extent of 42 per minute, but this was distinctly related to the gastric symptoms. The rise began only with the onset of nausea, and increased with the occurrence of vomiting, after which the pulse fell to an ordinary level: it became also soft and weak in proportion to its quickness, but he did not observe any decided fall below the normal rate at any period (Brit. and For. Rev., 1859).

These observations were carefully made, the pulse being examined every five minutes for several hours, but they illustrate the effect of only one or two doses. There can be little doubt that a longer course of the same, or a larger initial dose, would

have induced the slowing of pulse which has been verified by so many observers; but we may note a parallel observation made by Trousseau, that in some few persons taking antimony the pulse became and continued quick, as well as weak and irregular. Usually, as at first stated, slowing of the pulse is a marked and somewhat persistent effect of antimony, and especially so when vomiting does not occur at all, or after it has ceased: from six to ten beats per minute is an average amount of decrease after doses of 1 to 2 gr., but it may vary from three beats to forty (Péchohier, Bonamy). Gubler has noted a proportion between the ultimate fall and the primary increase. Arterial pressure is much diminished, and the curves of a sphygmogram may be almost effaced (Bordier); more or less venous congestion also occurs.

After very large doses, any acceleration is but slight and transient, before the blood-current becomes slow and almost imperceptible. In frogs, dogs, or rabbits, when a sufficient dose has been introduced by any channel, the cardiac contractions also soon become slower, weaker and irregular, the auricles contracting oftener than the ventricles. When death occurs from the drug it is said to be always through cardiac paralysis (Richardson), the general state of collapse being secondary to failure of the circulation. Arrest finally occurs in diastole, and irritability of the cardiac muscle is found to be impaired or lost (Radziejewski, Bellini), probably owing to a directly paralysing influence on the cardiac muscular structure when reached by the drug after absorption. When antimony is applied to the batrachian heart removed from the body, similar slowing and arrest take place after a brief period of acceleration, which is another reason for considering the action to be directly on the muscular structure. It is curious that in animals subjected to toxic doses, death can be delayed for some hours by dividing the vagi (Majendie) (*cf.* hydrocyanic acid). The effect on the circulation is thus seen to be primarily due to the direct action of the drug on the heart and vessels; but it partly depends (as is seen in the observations of the relation of the pulse to the nausea) on a reflex action through the nerves of the stomach. The alkalinity of the blood is said to be lessened.

Respiratory System.—In the experiments of Ackermann the number of respirations increased in direct relation with the

increase in the pulse rate; but under the continued influence of the drug, independently of irritant effects, and of any preventing lung disorder, the rate of respiration is slowed. It may be so by as much as half or two-thirds the normal rate, so that only six respirations occur per minute, and this without general distress or impairment of other functions (Trousseau).

After poisonous doses the breathing is very irregular, at one time hurried, short, and painful, at another extremely slow, with laboured and forcible inspiration and expiration: this is due in part to paralysis of the heart and other muscles, in part to impairment of reflex sensibility and to altered conditions of the blood. After death in such cases, Majendie, finding the lungs partially congested and hepatised, concluded that the action of antimony was specially exerted on these organs, and Mayerhofer certainly proved its elimination by their mucous membrane: ecchymoses and emphysema are found when the act of breathing has been very laboured.

The effect of the drug upon excretion of carbonic acid has been differently stated: some observers report it lessened in amount (Coze, Mialhe, Rabuteau), but some recent writers (Ringer, Bartholow) express an opposite opinion; having regard, however, to the sedative effects of sufficient doses, independently of inflammatory action, the former statement seems to me more in accordance with known facts. That *arsenic* lessens the excretion of carbonic acid is now recognised, and I should hesitate before ascribing to so closely an allied drug as antimony a directly opposite effect in this important particular.

Digestive System.—Upon the alimentary tract antimony acts as an irritant in greater or less degree, according to the dose: $\frac{1}{30}$ to $\frac{1}{15}$ gr. of the tartrate, or even less when repeated, will induce some sense of warmth in the stomach, and some increase of its secretions; $\frac{1}{8}$ to $\frac{1}{4}$ gr. will cause in addition, a feeling of soreness, a flow of saliva, impairment of appetite, and possibly nausea; $\frac{3}{4}$ to 1 gr. given in a glass of water, will usually induce vomiting within fifteen to thirty minutes. The vomiting is distressing in character, accompanied with shivering, much depression, retching, and persistent nausea: the ejecta contain mucus, and later, bile. The same dose generally purges, and if taken with a *large quantity* of water will be almost sure to do so, either

with or without vomiting. The evacuations at first are simply fluid, then mixed with free bile, and are passed with some straining and griping pain. It is noteworthy that a larger dose is required to produce these effects when given by intravenous injection than by the stomach.

Large doses of 10 to 20 gr. or more act very severely; the local irritation and burning pain are great; vomiting occurs quickly and with much distress; there is difficulty in swallowing, spasm of the œsophagus, severe tenesmus and cramp in the abdominal muscles, and profuse diarrhœa of sero-albuminous fluid, containing flocculi of detached epithelium (like the rice-water stools of cholera), and sometimes blood.

In fatal cases the mucous membrane of the stomach and of parts of the intestine, especially the lower portions and the rectum, have been found acutely congested or inflamed, softened, aphthous, or ulcerated: a characteristic pustular rash has been described, and changes like those produced by arsenic have occurred in the liver (Record, 1882).

*Conditions modifying the Action of Antimony.—Tolerance, etc.—*The preceding description requires to be qualified, especially in cases of what is called "tolerance". If the giving of antimony be commenced in fractional doses, and continued with very gradual increase, it is possible to produce full sedative effects without gastric disturbance. Again, in certain forms of illness, such as pneumonia, or in some nervous disorders, as chorea or delirium tremens, full doses may be given without any evidence of irritation, and then "tolerance" of the drug is said to be established. Further, in some instances, $\frac{1}{2}$ -dr. and 1-dr. doses have been taken without vomiting (Hicks, *Lancet*, ii., 1876), and in other cases of poisoning from very large doses the prominent symptoms have been those of collapse, and the patient has died without vomiting or purging, or complaint of pain. Indeed, not the least of the difficulties in studying the action of antimony we find in the circumstance that sometimes there is no *post-mortem* evidence of irritation or inflammation to be found, either in the stomach or intestine (Handfield Jones, Bellini, Böcker). One explanation offered of "tolerance" is that the irritant action of the first few doses arrests the secretion of acid gastric juice, as in fever, then subsequent doses meeting with no acid, are not much absorbed

and so produce little effect (Brunton) (*cf.* p. 425). As with other powerful drugs, there may also exist some idiosyncrasy in certain persons, leading to difference in result that we cannot otherwise explain, but the account I have given represents the effects as usually observed: as a rule, it acts with most intensity on the delicate, on women, and more especially on children, and in these subjects "tolerance" is less easily induced than in men, and lasts for a shorter time. When tolerance has once ceased, great care must be exercised in resuming the drug, for it will more readily excite gastric derangement (Trousseau).

Glandular System.—Moderate doses increase the secretion of the parotid, the pancreas, the liver, and the gastric and intestinal glands, the drug acting as a stimulant or irritant during its elimination by these structures. The increased secretion has been variously attributed to irritation of the gland-cells, and to paralysis of their controlling nerves: the former is the primary, the latter a secondary effect.

Cutaneous System.—Whether it has a like action on the sweat-glands has been disputed, and the increased perspiration which commonly follows its use has been attributed to the act of vomiting, or to the course of an illness (Trousseau). It is true that when the remedy is "tolerated" there is usually little sweating, but this need imply only that under certain conditions less of the drug is excreted by the skin. In my own experience, diaphoresis has occurred clearly from antimonial action, independently of vomiting, and this seems quite in accord with the increased cutaneous circulation and secretion from other glands. (I do not here refer to the profuse cold sweating of the later stages of poisoning,—the result of exhaustion.)

Neither do I see any difficulty in accepting the recorded cases of pustular eruption on the fauces or skin following the internal use of tartarated antimony (Gleaves, Böcker, Mayerhofer, Taylor). The drug is certainly eliminated to a greater or less extent by the skin—the acid sweat decomposes the double salt, and the liberated simple salt acts as an irritant. Given to frogs it acts on the skin somewhat like arsenic, but more rapidly and more completely; *e.g.*, it softens the cells, not only of the columnar, but also of the deeper layer—so that they become detached from each other and are rubbed off as a soft jelly.

In practice we do not see effects of pigmentation, etc., as we do from arsenic—probably because it is not administered so continuously.

Urinary System.—*Metabolism.*—There is difficulty in estimating exactly the effect of antimony on the kidneys, and statements with regard to it vary much. It is probable that more or less of the drug may be excreted by this channel according to circumstances, for, as already stated, Mayerhofer, experimenting on himself, could, at one time, detect it in his urine, and at another time, not; he found the amount of urine at first increased, afterwards lessened. Trousseau and Gubler report a marked increase in the secretion only when vomiting and purging were absent or slight, and this was the case also in Hannon's experiments. If the circulation be extremely depressed, or if choleraic symptoms occur, the urine is likely to become scanty, or even suppressed.

Other observers distinguish between the different constituents of the urine; Böcker, taking himself $2\frac{1}{2}$ gr. daily for nine days, found the urea and other urinary solids markedly lessened; and Beigel, giving a similar dose to four patients for four days, obtained the same results: in both instances, comparatively little food was taken. Parkes found the amount of urea increased after sulphuret of antimony; and several modern writers (Ringer, Bartholow, Stockman) describe a similar increase, relying, probably, on the observations of Ackermann. His subjects received a cup of coffee and then remained in bed for a day, taking from 1 to 2 gr. of tartar emetic, which caused emesis and often purgation. He reported that the water and the chlorides were diminished in proportion to the diarrhœa, but urea was increased by one-eighth, or even one-fourth, and uric acid and pigment were also present in larger amount: these results he attributed to increased metabolism. It is true that under such doses the tissues, especially the albuminous tissues, tend to break down and emaciation occurs, but small quantities moderate or diminish the nutritive processes, and lessen the excretion of urea as well as of carbonic acid, at the same time promoting the deposition of subcutaneous fat. As a curious illustration of its power to lessen excretion and lower true nutrition, we may refer to a custom common in Germany of using "glass of antimony" in the food to fatten fowls and animals, and there is confirmatory evidence of the power of the drug to pro-

duce fatty degeneration in the experiments of Salkowski, who found this change in the viscera of animals after adding 8 to 15 gr. per diem of an antimonial compound to their ordinary food.

Temperature.—There is a similar discrepancy in observations on temperature,—a discrepancy which must depend upon difference in dosage, or in continuance of the medication, or in the reaction of healthy as against weakly subjects. Thus, Ackermann found the hands and face became cold during the period of nausea, but after vomiting they became warmer, and the mouth temperature did not fall, but increased about 1° F. That is to say, the extremities become cold during the stage of nausea because less blood reaches them; then, when the nausea is over and the spasm of the vessels relaxes, they become warm again or even warmer than normal (Brunton).

Dr. Ringer made a very complete experiment when he gave $\frac{1}{2}$ gr. of tartar emetic every ten minutes for seven hours, inducing vomiting and sweating, and yet the temperature did not vary more than 0.4° F. On the other hand, Pécholier observed the temperature to fall in direct ratio with the pulse, and the amount of fall has been stated at from 1° to 3° C. (Hirtz, Gubler): a brief and slight preceding rise has been noted by the latter physician.

In cases of *poisoning* the depression of temperature is very marked, and in another series of experiments made by Ackermann on animals it amounted to nearly 7° C. in those that survived a *few* hours; this, however, must have been largely due to collapse.

Nervous and Muscular Systems.—These systems are first excited and then paralysed by antimony in varying degree, according to the dose and the amount of gastric irritation. In Kobert's experiments it was found to directly enfeeble muscle. Restlessness and pain may be at first marked, with general tremor and spasmodic contraction of the muscles either of the abdomen, the jaw, the œsophagus, or extremities, especially of the hands (case of Mrs. Prichard—cases by Orfila, Elliotson, etc.).

In animals, reflex sensibility is much diminished (Radziejewski), and some degree of motor palsy occurs: these effects, so far as they are central in origin, are spinal rather than cerebral, for they occur equally when the cerebral centre is separated. That they are due to the direct action of the drug on the nervous tissue, and not to its

indirect action through the circulation, is shown by the fact that in frogs the paralysis appears while the heart continues to beat. In man they have not been so marked, but great muscular prostration is quickly induced, and profound collapse is a characteristic symptom of antimonial poisoning : in some exceptional cases it has been more in evidence than any irritant symptoms. There may be temporary loss of consciousness and semi-narcotism, or convulsion, and later delirium (Orfila), but usually the mind remains, or becomes clear, before death.

Fatal Dose.—The ordinary fatal dose for an adult may be stated at 4 or 8 gr. ; for a child, $\frac{3}{4}$ gr.

If small doses be long continued, the symptoms may closely simulate those of some illness, being such as nausea with metallic taste, frequent vomiting, chronic diarrhœa alternating with constipation, small frequent pulse, faintness and muscular weakness, with loss of voice, coldness of surface and clammy sweats : sometimes there has been flushing with excitement, suggesting alcoholism. Death may be preceded by suppression of urine, fall of temperature, cyanosis, delirium and convulsions, local or general, as already mentioned. Many trials, such as those of Palmer and Prichard, show that this *ensemble* may be mistaken for natural disease.

Theory of Action.—There has been much discussion as to whether the vomiting and purging which are produced by antimony are due to direct gastro-intestinal irritation, or are secondary to an influence exerted on the vomiting-centres in the medulla oblongata by the drug after absorption. The former view was commonly accepted until Majendie's experiment of substituting in an animal a bladder for the natural stomach, and then causing vomiting by intravenous injection of antimony. Such an experiment seemed to prove that emesis was effected through the nervous centres independently of the stomach ; and besides this, the persistence of the nausea seemed to indicate more than an ordinary mechanical irritation. Chouppe has also concluded from recent experiments that although antimony *may* act by such irritation, it more usually acts after absorption. He divided the vagus nerve in dogs, and after subsidence of retching from the operation, injected antimony into the cellular tissue or veins, and vomiting followed as usual : as an experiment for contrast, he injected in other dogs

emetine, and when the vagi were divided this caused no vomiting (Abstract, *Lancet*, ii., 1874). The ascertained facts, however, seem to me to show that although under certain conditions such as result from large doses, the effect of tartar emetic is on the vomiting-centre, yet the earlier views that it is local irritation of the stomach and thus an *indirect* effect on the vomiting centres we have to deal with, are more correct and are supported by the following considerations: (1) Emesis has occurred before any antimony could be detected in the blood (Mayerhofer). (2) In several instances nearly the whole of a dose of antimony has been recovered from the vomited matters—implying that very little, if any, absorption could have occurred before vomiting (Radziejewski). (3) In almost all fatal cases marked congestion or signs of irritation have been found in the *stomach* after death, and this even when the drug has been given by the veins or other channels. It has been clearly proved that elimination occurs from the gastric membrane under such circumstances, and it is probable that in Majendie's experiment the drug was eliminated by the pharynx and by the intestine, and produced vomiting just as if introduced into the natural stomach (Hermann, Grimm, Brinton, Richardson). (4) A smaller dose will produce vomiting when given by the mouth than when given by the veins; this seems a crucial experiment on the point, and although an opposite statement has been made by some observers the former one has been verified by Hermann, Grimm and Kleimann; it is agreed, of course, that general symptoms occur also after, and in consequence of, absorption, and that nausea and prostration are prolonged in consequence of such absorption.

Tolerance we may explain in some instances, perhaps, by the fact of only partial absorption occurring, *e.g.*, through deficiency in the gastric secretions during fever; but this will not explain it so completely as some have supposed, because the induced feebleness of circulation and respiration, and occasional occurrence of organic lesions, prove that sufficient absorption must have taken place to cause the ordinary effects. A more reasonable explanation is to be found in the *impaired condition of the nervous system*, and especially the diminution of reflex excitability in the subjects of "tolerance" (*cf.* p. 420).

SYNERGISTS.—Other emetics such as ipecacuanha, and

other purgatives such as calomel, increase the effects of antimony. Sedatives such as bleeding, and more especially digitalis, conium, and veratrum, have an allied action : also other medicines which under certain circumstances quiet febrile excitement, as quinine in full doses, arsenic, bromides, citric and tartaric acids.

ANTAGONISTS AND INCOMPATIBLES.—Aromatic, alcoholic, and other diffusible stimulants counteract the depressant effects of antimony. Narcotics, and especially opium, hinder its special action (Rasori)—Gubler calculates that opium lessens its power by one-half, and considers it much better to give a half-dose in any case, or to give the narcotic separately, than to combine such antagonists. Graves, however, has proved a clinical value in the combination, and Laennec found antimony better borne when conjoined with opium and aromatics.

Cold acts as a partial preventer of vomiting, and *warmth* of diarrhoea. *Mechanical antidotes* are such as oil, thickened milk, and mucilaginous substances ; tannin, in all its forms, is a powerful *chemical* antidote,—decoctions of oak and cinchona bark, gall-nuts, strong tea, etc., may be used, and life has been saved by these agents in apparently hopeless cases of poisoning. Small doses of sodium bicarbonate mixed with tea, or some other substance containing tannin, are also useful. Diffusible stimulants like spirits of ether or ammonia should be given to counteract the collapse.

THERAPEUTICAL ACTION.—*External.*—The ointment acts as a strong local irritant, and was much employed when counter-irritation was more highly esteemed than it is at present. The pustulation caused by antimony is more painful, but perhaps more active in its good results than that produced by croton oil.

Phthisis.—In the earlier stages of this disease, when there is evidence of local pulmonary congestion with pain and oppression, and in the later stages when acute general symptoms are not urgent, I have known it serviceable.

Meningitis.—**Hydrocephalus.**—In these maladies, the ointment has been applied over the shaven scalp, but the results certainly do not compensate for the suffering caused.

Orchitis.—**Ovaritis.**—Frictions with the ointment have been made in orchitis, along the line of the spermatic cord as far as

the scrotum, the skin having been previously punctured (Pract., 1860). I cannot think it desirable; it has proved unsuccessful under my own observation. Dr. Rigby speaks very highly of the good effect of counter-irritation by antimonial ointment in ovaritis.

THERAPEUTICAL ACTION.—*Internal.*—The double power of antimony to control the circulation and act as a sedative to the nervous system, at the same time that it increases secretion, indicates its use in many diseases, and especially in those of febrile and inflammatory character; on the other hand, the extreme depression that may be caused by it has led to serious results in incautious hands; hence much controversy as to the true value of the drug, and whilst by some writers it has been extolled as the best of remedies, it has been described by others as too dangerous a poison to be used.

Forbidden in France by special law in the sixteenth century, it was not long afterwards received into the Codex, and about the same time our "Earl of Warwick's powder," consisting of the sulphuret of antimony, with cream of tartar and scammony, obtained a wide reputation. The tartrate of antimony and potassium was introduced somewhat later (by Mynsicht), and has continued in general estimation and daily use down to our own time.

Within the last twenty years, however, and since the value of tonic and restorative treatment has been better recognised, antimony has, like bleeding and other depressants, been more rarely prescribed, and at present it may be questioned whether its great therapeutical powers are sufficiently appreciated; but it can exert marked influence on certain pathological states, which either cause or complicate many maladies.

Fevers.—At the commencement of an attack, when gastric disorder was very marked, an antimonial emetic was formerly much commended. Dr. Gregory often employed it in these circumstances, but he also pointed out the danger of inducing irritability of the stomach, and even inflammation. Dr. Graves and others have taught that such an emetic, given within thirty-six hours of the initial rigor, would often abort the fever; but this is difficult to prove, and is not generally accepted. Modern practice teaches us that nausea and vomiting are usually needless

annoyances to the patient, though if induced in the early stages, vomiting may certainly relieve headache and severe gastric congestion.

Dr. Graves originated and highly praised also the administration of antimony in fever (especially *typhus*) at a stage when cerebral complications are sometimes very severe, *e.g.*, from the seventh to the ninth day. Thus, to a strong adult, suffering from complete insomnia, illusions of the senses, delirium, continued tremor and subsultus, "cerebral" respiration, very quick and weak pulse, sordes, and every symptom of the worst augury, $\frac{1}{4}$ gr. of tartar emetic in water was given every hour: the patient vomited freely (though not immediately) after each of the first four doses, then purging began, the general condition improved, and the man slept: after temporary omission of the medicine, 2 min. of "black drop" (opium) were given every two hours, and on the following day there was free perspiration, natural sleep, and a rational mind; ultimately a good recovery followed (Clin. Lectures).

In other equally severe cases the same dose of antimony has been given from the first with 2 or 3 min. of laudanum, and the results have been such as to warrant much confidence in this method of treatment; it is necessary, however, to use it cautiously, and to bear in mind its weakening effect upon the cardiac muscle, which is already enfeebled from the effect of the disease (Murchison).

Enteric Fever.—Antimony has been commended in this fever, but the intestinal condition requires exceptional caution in its use; it does not of itself forbid the remedy, for diarrhoea and pain have often subsided under it (Trousseau), and when the lungs are implicated it may be useful.

M. Bériard records a case of fever with secondary pneumonia and delirium, rapidly passing into a hopeless comatose condition, which was relieved at once by free vomiting and purging from a large dose (nearly 6 gr.) of tartar emetic, with ultimate recovery (Bull. de Thérap., 1873).

Scarlet Fever.—*Measles.*—*Small-pox.*—In these disorders, especially when the eruption is scanty or suppressed, antimony may be useful by stimulating the activity of the skin, and thus relieving the febrile condition and obviating grave symptoms.

I have given tartar emetic in small-pox in varied doses, but have never known it exert a modifying influence on the disease itself. In certain complications, however, such as pneumonia, bronchitis, or acute delirium, doses of $\frac{1}{16}$ to $\frac{1}{4}$ gr. every two or three hours have given relief.

Antimony is useful in the bronchial catarrh which is often a serious complication of measles; besides controlling the general pyrexia, it relieves the oppression of the chest, acts as an expectorant, and tends to diminish a too abundant secretion of mucus, probably by lessening congestion.

If $\frac{1}{2}$ gr. of tartarated antimony be dissolved in 4 oz. of distilled water, a teaspoonful may be given frequently or occasionally, according to the severity of the cough or the oppression. In the case of weakly children, the amount of depression which may be induced requires to be carefully watched.

Rheumatic Fever.—Laennec, Bricheteau, and other eminent physicians of a past generation advocated the use of large and repeated doses in acute rheumatism; but later experience is against their adoption. I formerly used $\frac{1}{4}$ -gr. doses with advantage, especially when the temperature was not very high. In serous effusions complicating acute rheumatism, the treatment which was often successfully adopted by Jaccoud involved the production of both the emetic and purgative effects of the drug: 30 centigrams of the tartrate were dissolved in 130 grams of julep, and of this a tablespoonful was given hourly, till full effects were produced; a dose of bark was then given, and after an interval, if the temperature again rose, the antimonial was repeated (quoted by Nias, *Pract.*, ii., 1885). He also used antimony in depressant doses or until vomiting occurred, in cases where the pain has been relieved by salicylates or other remedies, but where high temperature remained or hyperpyrexia developed (*ib.*, ii., 1888).

Lumbago.—In obstinate cases of ordinary lumbago and local muscular rheumatism, I have ordered the same dose every one or two hours for a short time with excellent results.

Erysipelas.—Desault recommended the frequent use of minute doses of antimony in erysipelas, giving 1 gr. dissolved in a quart of water in the course of twenty-four hours.

Traumatic Pyrexia.—In febrile conditions resulting from severe injury, antimony has been found useful. Thus, Mr. Denny

found it "act like a charm" in a case of gun-shot wound of the chest with inflammatory reaction, rigors, delirium, etc.; some nausea was induced, the pain quickly subsided, and in twelve hours the fever aborted, and sleep set in (B. M. J., i., 1871). Dr. Payne has also used the drug in surgical cases, especially fractures, and finds recovery rapid and fever rare when it is used; he, however, gives opium at the same time (B. M. J., i., 1884). Surgeon-Major Lawrie speaks in similar terms of its value in the small frequent dose, by which method he is able to use it safely even when muco-enteritis is present (Internat. Jour., 1890). Speaking, however, from large experience, I am satisfied that aconite is a more trustworthy remedy in such cases.

Acute Inflammations—Orchitis, Tonsillitis, etc.—In minor local forms of inflammation, such as of the breast or testicle, of the tonsil or parotid, or of a varicose vein, the good effect of small doses of tartar emetic is often conspicuous. Dr. Beatty especially noted their power of controlling mammary inflammation, as if by "specific action on the gland." After purgation, he gave $\frac{1}{16}$ gr. every hour, never desiring an emetic action, but not objecting to slight nausea (Dub. Journ., vol. iv.). Dr. Churchill found the same plan "more effective than any other" (Midwifery). A case of inflamed varix cured by this method is related by Dr. Spender in his essay on the advantages of small, frequent doses, and he believes that the dose may be adjusted with mathematical precision and certainty: " $\frac{1}{20}$ to $\frac{1}{16}$ gr. given every hour is bound to control a local phlegmon." I have found it good in tonsillitis and parotitis, the pain, congestion, and pyrexia being often quickly relieved, and yet this is not the treatment I usually adopt, nor do I think it so good as that by aconite or belladonna. Surgeon-Major Lawrie recommends the drug in cases of acute gonorrhœa, giving 15 min. of antimonial wine every two hours, and this combined with injections of corrosive sublimate (1 in 15,000) has, in his hands, rarely failed (Ind. Med. Gaz., 1885).

Purulent and Strumous Ophthalmiæ.—In these affections, tartar emetic was a usual remedy some years ago, and doubtless acted by abating local congestion; modern practice, however, places more reliance on the use of topical remedies and of tonics.

Acute Skin Diseases.—When acute eczema occurs in per-

sons of full habit—especially if also of gouty tendencies—and when pyrexia, severe local irritation, gastric disorder, and loaded urine are present, I have seen much advantage from combining antimony with magnesia or other saline aperients, or with diuretics. Meade also writes in its favour (B. M. J., ii., 1864). The claims of antimony as a remedy in inflammations of the skin have been further advocated by Mr. Malcolm Morris (B. M. J., ii., 1883) and Dr. Spender (Pract., i., 1885). Both of these observers give small and frequent doses, 7 to 15 min. of the wine, or $\frac{1}{32}$ to $\frac{1}{16}$ of tartar emetic. Pointing out the chemical analogy between arsenic and antimony, Mr. Morris contends that the latter drug is often as useful as the former in cases of eczema, erythema, prurigo, urticaria and psoriasis.

Dr. Allan Jamieson has recorded cases of dermatitis, eczema, and lichen planus benefited by the same treatment, a usual dose being, however, $\frac{1}{8}$ th gr. (Brit. Journ. Dermatol., Sept., 1891). In conjunction with Dr. Douglas he has published some remarkable cases of psoriasis passing into exfoliative dermatitis, markedly relieved by antimony: under other treatment one patient got worse from admission to hospital in October till January, but after this was commenced he was convalescent in six weeks: the drug was found to lower temperature, to soften and improve the nutrition of the skin, to diminish hyperæmia and augment the insensible perspiration,—it did not much affect tissue change: it was good in early congestive eczema and the later dry stages, not when there was oozing:—it contrasted advantageously with pilocarpine (Edin. Med. Journ., June, 1892).

Bronchitis.—Tartar emetic seems to me to exert an almost specific effect on the inflamed bronchial mucous membrane. In the case of old people it is useful, especially when the cough is convulsive in character, most troublesome at night, and attended with loud wheezing respiration, paroxysmal dyspnoea, and profuse secretion of mucus, which is with difficulty expectorated. When inflammation affects the smaller tubes of young adults, an emetic dose may be found sometimes desirable, but as a rule $\frac{1}{16}$ to $\frac{1}{8}$ gr. every two or three hours will suffice to render free and less tenacious the bronchial secretion, to lower the blood-tension, diminish pyrexia, and relieve local congestion and oppression. The action of the skin and of the kidneys is increased usually in

inverse ratio—if one is more, the other is less marked. If cough be very severe, a little morphine or belladonna may be combined with the antimony, whilst in later stages, if more stimulus to expectoration is needed, squill is a useful adjunct.

In the *capillary bronchitis* of children, tartar emetic often proves valuable. Referring to the notes of thirty-three cases treated by it, I find they were all under two and a half years old, and suffered from distressing paroxysmal cough, which caused much exhaustion; the respiration was much quickened, the pulse 130 to 140, small and feeble, the temperature 101° to 103° F.; there were the ordinary physical signs in the lungs, the face was dusky and cedematous, the skin covered with a clammy moisture; restlessness was extreme, and cerebral symptoms, such as stupor, delirium, and even in some cases coma, were present; these patients were ordered small but frequent doses, $\frac{1}{64}$ gr. every half-hour for four doses, afterwards every one to three hours, according to the amount of cough or oppression: of the thirty-three cases, ten vomited within two hours of the first dose, and all showed signs of exhaustion under the medicine, but all of them made good recoveries:—with larger doses I have seen serious depression rapidly develop in old people and young children.

Pleurisy.—In this and other cases of serous effusion, Dr. Nias, after referring to the successful practice of Dr. A. Billing (*Principles of Medicine*), recommends the more frequent use of antimonials, and has recorded numerous cases of good results following their administration, more especially in pleurisy (*Pract.*, ii., 1885)—Napier corroborates (*ib.*).

Pneumonia.—The proper treatment of this disease has long been a crucial question, and opinions have varied as to the amount of influence possessed over it by antimony. Very much depends upon the time and mode of administration. Rasori, with his “contra-stimulant” method, aimed at exciting in or near the inflamed part an artificial irritation more powerful than the original disease, and gave from the commencement large doses, which he rapidly made enormous. Thus one adult was ordered on the first day about 24 gr., and by the eighth 144 gr. per diem; the amount was then reduced up to the twelfth day, when death occurred: the same patient was bled several times in the course of the attack, this being considered to favour the special action of

the drug ; there was no evidence of its irritant effect, but such a mode of treatment could not be sanctioned at the present time ; and although the mortality in the practice of the Italian physician was less than that of his contemporaries, it was yet very large, and must not be taken as illustrating the results of a judicious use of antimony.

Laennec usually recommended 1 gr. every two hours till 6 gr. had been taken, and then an intermission for the same period ; sometimes, however, he increased the dose gradually to 30 gr. in the twenty-four hours. His mortality was about one in twenty, reckoning only well marked cases ; that of Louis, following a very similar method, was about three in twenty. Trousseau and Grisolles, who have treated the subject fully, agree in speaking highly of this antimonial treatment, the former, indeed, so highly that he foresees "a future generation will tax him with exaggeration." The latter observer has specially analysed forty-four cases, showing some strikingly good results as to relief of signs and symptoms and as to brief duration, but these reports must be read in the light of our later knowledge of the *natural history* of pneumonia, which would explain some of the rapid recoveries by the occurrence of a natural crisis : vomiting and purging were often caused to a serious extent.

Dr. W. Stokes was one of the earliest British physicians to report favourably on this remedy in pneumonia ; he stated that it acted better when given before hepatisation had commenced than afterwards. Sir Thos. Watson also commended it, especially in the stage of engorgement, and Dr. W. H. Walshe laid stress upon its value when not given to emesis. Dr. C. J. B. Williams advised $\frac{1}{2}$ to $\frac{1}{4}$ gr. doses every two, three or four hours during the early stages, combining them with citrate or nitrate of potassium (Med. Times, i., 1872).

Three grains is the minimum, and 16 the maximum daily dose recommended by the German Pharmacopœia, and this nearly accords with the quantities already mentioned ; with them vomiting has generally been observed at first, and is said to have proved useful rather than otherwise, and later on tolerance has become established, so that irritant effects have not been marked ; nevertheless, smaller doses are to be preferred. I have found the best results from those ranging between $\frac{1}{100}$ and $\frac{1}{4}$ gr. given every

two or three hours, beginning with the smaller amount and increasing gradually, so as to produce general effects without vomiting, or even nausea. In severe cases with high temperature, small frequent doses of *aconite* are valuable in combination or alternation with antimony, and I believe by this treatment may be effected all the good Rasori expected from preliminary bleedings. In moderately severe attacks with less pyrexia, antimony alone is a good and sufficient treatment from the first, although its special value is shown best when "resolution" has begun; it assists the clearing up of the consolidated lung. Another indication for the remedy is to be found in the presence of various complications, such as bronchitis, or whooping-cough, or when the malady deviates from an ordinary course, or occurs after influenza or in emphysematous subjects; then I have reason to express the greatest confidence in it. It is true that Nothnagel, Nöbiling, and others hold a different opinion; but this may be attributed partly to giving larger doses than the patients could bear, partly to the indiscriminate use of the medicine in all stages and phases of the disease; for Nöbiling speaks of emetic doses which induced *cardiac collapse*, and of small doses being continued till *intestinal ulceration* occurred—results of which I have never seen any indication under the method above recommended. I must, however, guard myself from seeming to imply that it is the only or the best treatment for every individual case: in exhausted broken-down subjects the appropriate time for it is but short, and ammonia, bark, and alcohol must soon replace it, whilst in septic forms of the disorder, which indeed are not infrequent, the tincture of the perchloride of iron is rather indicated.

In the serious *lobar pneumonia*, as it commonly affects young children, many authors—Stillé, for instance—question the propriety of giving antimony in any dose, because of the risk of sudden depressing effects; this must be borne in mind, but I have seen the remedy so efficient that I advise its employment very much as in the lobular form connected with capillary bronchitis.

Sir George Buchanan, whilst hesitating to recommend antimony as a usual treatment, records that he has seen more benefit from emetic doses of it given at an early period ($\frac{1}{8}$ to $\frac{1}{4}$ gr. every quarter of an hour till vomiting occurred) than from any single

remedy—it seemed to control the severe symptoms and secure a favourable progress afterwards (Lancet, i., 1868); this is, of course, one mode of using the drug, but I prefer small continued doses. In a careful paper giving comparative results of treatment by aconite, quinine, ammonia, and antimony in 213 cases, Dr. Arthur Jameson concludes that the last gave the best results both as to present relief and lessening of after complications. He had reason to prefer small doses frequently repeated, about $\frac{1}{20}$ gr. every hour at first for young adults, less frequently when the symptoms were relieved, but continued for some days or a week after the temperature had fallen to normal; he met with neither sickness, diarrhoea, nor cardiac failure (B. M. J., i., 1888).

In cases of *phthisis with intercurrent acute pneumonic attacks*, the remedy is often as useful as in the ordinary malady, but care must be taken to avoid emetic or irritant effects, because of the possibly tuberculous condition of the intestine. In “incipient” phthisis, during the stage of cachexia with febrile reaction, small doses lessen irritation and congestion; and even in the developed malady, when there is general pyrexia and constant irritative cough it often relieves, rendering the cough “softer” and expectoration easier.

Laryngitis.—Catarrhal Croup.—In laryngitis, occurring especially in young children (who are subject to recurrences of it from cold, indigestion, etc.), beginning with hoarseness and cough and developing rapidly by night with urgent dyspnoea and stridor, antimony may be very serviceable, and may be combined or alternated with ipecacuanha. It was formerly prescribed in all forms of “croup” (which were not well distinguished from each other), and in large doses. Elliotson gave $\frac{1}{4}$ or $\frac{1}{2}$ gr. every four hours (up to 30 gr.)—and Meek $\frac{1}{2}$ to 1 gr., and some spasm-vomiting occurred, but good recoveries followed—Kesteven however showed injurious results (Med. Times, ii., 1856). Klemon limited its use to a few emetic doses in cases with severe spasm. Bouchut gave $\frac{1}{6}$ to $\frac{1}{3}$ gr. frequently, till emesis or diarrhoea occurred, and recorded successful cases (Lancet, ii., 1872).

In catarrhal croup when an emetic action is required, its depressant action is often so great that I myself never give it for this purpose, especially as there are many other remedies at

hand such as ipecacuanha, sulphate of zinc, etc. Its use ought to be confined in these cases to its diaphoretic, sedative and expectorant action and to its action on the bronchial mucous membrane generally, and this can be secured by doses of $\frac{1}{100}$ gr. or less every two to four hours. In some cases when large doses are given, tolerance of the drug sets in when it ceases to produce vomiting, but in the majority depression and collapse follow, and it is to be feared that the patient has sometimes died from the effects of the drug rather than from the disease.

I recommend rather a solution to be made with 1 gr. in 4 oz. of water, and of this one teaspoonful ($\frac{1}{32}$ gr.) may be given every half-hour for four or five doses; it will often suffice to excite vomiting, which, however, is not desirable unless there be evident obstruction in the trachea; so soon as this obstruction is lessened, the remedy should only be given at intervals of two to three hours: the dyspnœa is commonly removed for a time after vomiting, but if it recur the same effect should be induced again: of course, the patient's strength is to be supported by suitable nourishment, and fomentations, sprays, steaming and other adjuvants may be used. With this plan of treatment I have many times noticed an early abatement of the cough, dyspnœa, and hoarseness, lowering of the pulse rate, return of natural warmth and colour, and quiet sleep. If the dose mentioned be found really too small in a given instance, it may be cautiously increased. The main point in selecting this treatment for a given case turns on the accuracy of diagnosis. True membranous laryngitis with strepto- or staphylo-coccus infection, *e.g.*, during measles, influenza, etc., may also be thus treated with advantage in the early stages, but if there be suspicion of laryngeal diphtheria, then this drug is better omitted for fear of depression, and antitoxin treatment early adopted.

Spasmodic Croup—Laryngismus Stridulus.—Antimonial emetics have been strongly recommended to arrest the paroxysms of this malady (Stillé), but yet, remembering its clear connection with rachitis and impaired nutrition, tartar emetic is not the remedy we should choose for curing its essential cause: bromides, belladonna, and cold bathing, with tonics and nutrients, are better indicated.

Nephritis.—In acute nephritis, whether induced by cold or by fever, antimony has been specially commended by Dr. Bence

Jones, Sir Thomas Barlow, and others (Guy's Reports, vol. x.). It would certainly seem, *a priori*, that the action of small doses on the skin and the intestinal tract, as well as on the inflamed organ, should be of favourable character, but practically I have seldom found it to be so. Tartar emetic does not appear to exert any direct special power in controlling disease of the genito-urinary mucous membrane.

Muscular Spasm.—Rigidity of Os Uteri.—Muscular spasm, such as occurs in dislocations, herniæ, etc., may certainly be relieved by emetic or nauseant doses of antimony, and these were, at one time, commonly employed.

In difficult labour connected with rigidity of the muscular structure of the cervix uteri and perineum, relief may also be given by the same means. Dr. Kennedy of Dublin strongly recommended this treatment, and Dr. Gilmour (Liverpool) quoted a large experience in its favour; he claimed for it also not only an immediate favourable effect, but a good influence on the after-progress of the case, as he found a marked freedom from inflammations where it had been used (*Lancet*, ii., 1852): practically, however, chloroform has superseded it. It has sometimes been injected into the veins to cause vomiting in cases of obstruction in the œsophagus from impaction of a foreign body, and to help the expulsion of a calculus in the gall duct which would not now be chosen for such purposes.

For **Intestinal Colic** tartar emetic has sometimes been given successfully by enema. In a case dependent upon obstruction, 3 gr. dissolved in 8 oz. of water were injected per rectum, and after some hours the obstruction yielded and the colic subsided, without additional nausea or prostration (*Lancet*, i., 1856).

Constipation.—In obstinate cases connected, in part at least, with deficient intestinal secretion, and occurring especially in old people, small doses of tartar emetic will assist the action of saline purgatives such as sulphate of magnesia. Dr. Nevins has recorded a good illustration of this, and finds that less than $\frac{1}{4}$ gr. doses will usually suffice (*Comment.*, Lond. Pharm.).

It has been maintained by some distinguished writers (Gubler, Chomel, Rayer, etc.), that not only the above-described but all other therapeutical effects of antimony are dependent upon, or

connected with, its emetic, or at least its nauseant action, and are explained either by an elimination of morbid material, or by the profound disturbance and subsequent reaction induced in the economy; but—not to speak of the older cases in which benefit was conferred during “tolerance,” *i.e.*, when there was little or no vomiting—I am satisfied that most maladies are better treated by small and frequent doses, which do not cause vomiting, and that only a few cases require the production of nausea.

Mania.—Melancholia.—There can be no doubt that the large doses—12 to 30 gr.—formerly given to patients with mental disease, and especially to those suffering from acute or violent mania, served the purpose of quieting their violence for a time, but the general results were injurious (Greisinger), and professional opinion is justly opposed to producing temporary quiet by this means (Bucknill). A smaller quantity, however— $\frac{1}{2}$ to 1 gr., thrice daily—I have often known to be well tolerated by men in fair bodily health, and it certainly acts better when nausea and depression are not induced. The same observation has been made by Schroeder van der Kolk, a deservedly high authority: he has seen marked benefit from the remedy, and recommends it in pill after meals (to avoid vomiting), the dose being cautiously increased from $\frac{1}{4}$ gr.

In **Puerperal Mania** the last-named physician has also found small repeated doses useful, and Dr. E. Kennedy recommends them especially for phlegmatic patients (*Amer. Journ.*, v. 17). Dr. Madden has seen doses of $\frac{1}{2}$ gr. every four hours act very favourably, subduing delirium in a comparatively short time; sometimes he has used doses of 1 gr., which quieted excitement still more quickly, but were liable to depress the action of the heart unduly (*Med.-Chir. Rev.*, ii., 1871).

Puerperal Convulsions.—For convulsions occurring in vigorous muscular objects with high arterial tension, it is possible that antimony may be sometimes indicated; it has been with advantage combined with bromide of potassium (*Pract.*, ii., 1869). Before the latter drug came into use, I often had recourse to antimony, and in cases connected with renal disorder I observed relief, mainly owing as it seemed to increased activity of the cutaneous and intestinal glands.

Delirium Tremens.—Though antimony is seldom now pre-

scribed for this condition, the good results obtained from it, by Dr. Peddie especially, require some notice. He speaks of uniform success in upwards of eighty cases, treated mainly by $\frac{1}{2}$ to $\frac{1}{4}$ gr. doses, given every two hours until improvement set in; emetic action was not marked, but occurred to some extent with the early doses: secretion from the kidneys and the skin was increased, but he attributed the benefit rather to a sedative effect on the nervous system and the lowering of vascular excitement (Edin. Month. Journ., 1854). In America and in Germany larger doses have been successfully used—Schroff, for instance, giving 4 to 6 gr. daily, and others the same dose every hour. The practice, however, is dangerous, because in this malady the circulation fails so readily, and the late Dr. Anstie pointed out that antimonial treatment, though certainly successful in some cases, has ended unfortunately in others (Reynolds' System, ii.). I have found its moderate use valuable in young robust men, especially in the first attack, and even when much gastric derangement was present: it is not so suitable for old or debauched subjects.

Chorea.—The emetic action of antimony has been utilised for the relief of chorea, and the influence of the remedy has been explained as reflected through the vagus nerve to its central origin in the medulla, inducing sedative effects in that part (Ringer). Boulay and others have recorded successful cases from the use of nauseating doses (Bull. de Thérap., v., 52-54; Lond. Med. Rev., 1861), and Dr. West recommended it; but I cannot consider it a desirable treatment, nor is the evidence in its favour strong. Comparing it with arsenical treatment in twelve cases in Parisian hospitals, only half the number were reported cured by antimony, and some of these lasted long enough at least for natural recovery (fifty-eight days); whereas of eleven cases treated by arsenic all got well (M. Long).

Asthma.—Some forms, especially of dry spasmodic asthma, are much relieved by repeated small doses. Dr. Ringer has noted their value in attacks of wheezing and orthopnoea of asthmatic character to which some children are subject after exposure to cold, and which sometimes follow measles. In such cases he recommends one teaspoonful every quarter of an hour of a solution containing only 1 gr. in $\frac{1}{2}$ pint of water: even this amount

may cause vomiting, though that effect is not necessary for relief. Dr. Koch has remarked that the remedy is most useful when the attacks are brought on by peripheral irritation (cold, etc.), rather than by emotional causes; and he speaks highly of a combination with *arsenic acid*—the *arsenate* of antimony—which he administers in the form of vapour from a cigarette (Pract., vol. iv.).

Emphysema.—Dr. Koch has found the same salt act well as a nervine and muscular tonic in emphysema, and according to my experience it certainly deserves further trial.

CONTRA-INDICATIONS.—General feebleness, and especially feebleness of the circulation or digestion, would usually prevent the giving of antimony; hence it should rarely be prescribed in *infancy* or in *advanced life*. To children it has proved specially dangerous, by sometimes inducing without warning a condition of collapse, but a remedy so valuable in their acute inflammatory affections should not be wholly withheld: in old persons it is more liable to derange the stomach. Before emetic doses are ordered for a patient, investigation should be made as to the existence of hernia, aneurism or other arterial or cardiac disease, uterine displacements, or pregnancy: such conditions should contra-indicate the production of vomiting.

PREPARATIONS AND DOSE.—*Antimonium sulphuratum*: dose, 1 to 2 gr. as an *alterative*; 10 to 20 gr. as an emetic; is seldom prescribed except in the compound calomel pill (Plummer's). *Antimonium tartaratum*: dose as a diaphoretic, $\frac{1}{24}$ to $\frac{1}{8}$ gr.; as an emetic, 1 to 2 gr., often given dissolved in plain water, but the pharmacopœial solution of it is the *Vinum antimoniale*, containing 2 gr. to the ounce; this is convenient for giving small doses of the drug, especially in febrile conditions, but is not very suitable when larger quantities for depressant effects are required. Dose: as *diaphoretic and expectorant*, $\frac{1}{24}$ to $\frac{1}{8}$ gr. of the powder, or 10 to 30 min. of the wine every one to three hours; as an emetic for children, $\frac{1}{2}$ to 1 fl. dr. of the wine often repeated; as *vascular depressant, or sedative*, $\frac{1}{15}$ to 1 gr.; as an emetic, 1 to 2 gr. and upwards. *Unguentum antimonii tartarati* (not official; contains 1 part of tartarated antimony to 4 of simple ointment). *Antimonii oxidum*: dose, 1 to 2 gr. *Pulvis antimonialis* (1 gr. antimonious oxide in 3 gr.), the official substitute for James's powder: dose, 3 to 6 gr.—the latter dose causes vomiting. *Antimonium Nigrum Purificatum*.

ADULTERATIONS.—The powdered tartar emetic may contain free tartrate of potash, lime, copper, iron, or arsenic.

ARGENTUM—SILVER, $\text{Ag} = 108$ (107.11).

This metal occurs pure in nature, but more often in the form of alloy, as with lead (galena), or combined with sulphur (argentite), chlorine (horn silver), iodine, bromine, etc.

ARGENTI NITRAS—SILVER NITRATE ($\text{AgNO}_3 = 170$).

CHARACTERS AND TESTS.—The crystals are tabular and colourless (the primary form is the right rhombic prism), and they form a neutral solution with distilled water: their specific gravity is 4.3. They are soluble in 4 parts of rectified spirit; when pure they do not blacken on exposure to light, but do so, and readily decompose, on continued contact with any organic substance.

An aqueous solution of the nitrate is precipitated by any soluble chloride, a characteristic curdy-white chloride of silver being formed, which becomes dark on exposure to the air: it is soluble in ammonia, insoluble in nitric acid. A black sulphide of silver is precipitated from a solution of the nitrate by passing sulphuretted hydrogen through it.

Argenti nitras induratus consists of 95 parts of silver nitrate fused with 5 parts of potassium nitrate into cylindrical rods or cones which are white or greyish-white in colour.

Argenti nitras mitigatus (mitigated caustic) is identical with the old Argenti et Potassii Nitrates, and contains 1 part of the former to 2 of the latter fused together and moulded.

ARGENTI OXIDUM—OXIDE OF SILVER ($\text{Ag}_2\text{O} = 232$).

CHARACTERS AND TESTS.—It occurs as an olive-brown powder which has a specific gravity of 7.2. It is reduced to the metallic state by a red heat with evolution of oxygen, is soluble in ammonia and in nitric acid, but slightly soluble in water, to which it gives a metallic taste and an alkaline reaction.

Chloride of Silver, AgCl (not official).—It is readily obtained by decomposing any silver salt with hydrochloric acid, when it precipitates as a white caseous powder (horn silver): it darkens on exposure, and is soluble in ammonia.

The ammonio-chloride (not official) is an unstable salt, soluble in water. The *chloro-albuminate*, the *iodide* (U.S.P.), and the *double iodide* of silver and potassium are soluble salts that do not coagulate albumin. The *hyposulphite* of sodium and silver

is astringent and less irritant than the nitrate; the *cyanide* is said to be more readily absorbed.

Argentol is a compound of silver and oxychinoline, not very stable and rather insoluble; it is antiseptic, and is used in powder or ointment, 1 or 2 per cent. like iodoform, or in weaker emulsion.

Argonin is a white neutral compound of nitrate of silver and casein-soda in powder form; it is soluble in water and antiseptic, and is used in injection 1 to 10 per cent.

Protargol, a greyish powder, contains 8 per cent. of silver combined with proteids; it is soluble, antiseptic and non-irritant. Metallic silver is also germicidal, especially in the soluble colloid form, and the citrate (itrol) and the lactate (actol) are whitish, odourless, non-caustic powders of marked antiseptic power—the latter coagulates albumin, and may irritate; it is more soluble (1 in 15 of water): the citrate only 1 in 4,000.

Argentamine is a colourless alkaline, non-caustic, antiseptic solution of silver phosphate in ethylene diamine.

ABSORPTION AND ELIMINATION.—Nitrate of silver, when taken into the stomach, forms with the mucus and epithelium a thin pellicle, which to some extent hinders absorption. It has a special affinity for the cement substance of epithelial tissues, and the ground substance of connective tissues, and is employed by histologists for staining them a dark brown colour. The chemical change which all silver salts undergo more or less, when in contact with the gastric secretions, results in the formation of a double chloride of silver and sodium, and although *ordinary* chloride of silver is insoluble in water, this *double* chloride is readily dissolved by the gastric fluids; its combination with peptones is also soluble (Bogolowsky, Virchow's Archiv, xlv., 1869, and others). As chloride and albuminate it passes into the blood, and circulates with it, being retained in solution by the alkaline plasma (Rouget), though Frommann thought that it separated in the molecular form (Archiv f. Path. Anat., 1859). Dragendorff considers that the chemical changes occur chiefly in the duodenum, and that the gastric juice being here neutralised, silver sulphide is ultimately formed: certainly of unabsorbed silver compounds the greater part passes off by the bowel as sulphuret, colouring grey

or black the mucous membrane and the fæces. More of the salt will be absorbed if given in solution in distilled water on an empty stomach, than when given in pill in the ordinary manner; Riemer has shown that in pills (? bread) $\frac{4}{5}$ of the silver nitrate is decomposed even before administration (Archiv für Heilk., xvi., 1875). The same observer also sought to prove that molecules of silver pass in a mechanical manner through the intestinal walls, but Fragstein could detect no absorption of freshly precipitated silver-chloride introduced into the intestine of frogs (Berlin Klin. Woch., 1877). Orfila and Heller failed to find traces of silver in the blood after its administration; but Orfila and Panizza found it in the urine, and Cloez isolated a globule of the metal from the collected urine of several patients at the Salpêtrière. It has been found also in the liver and the bile, and some is eliminated by the cutaneous glands. Rozsahezzi found it in the intestinal contents, after its hypodermic injection.

The most important practical point is, that elimination of silver salts by any channel occurs but *slowly*, so that if they are taken continuously for a long time the reduced metal becomes deposited in the tissues, giving them a dark-grey coloration known as "*argyria*". The gums show the earliest indication of this condition by a bluish line (which is darker than that produced by lead), and parts exposed to light show the colour more than others—thus the lunula of the nail (Falck), the eyes, the face and hands are affected early; the deposit is in the true skin (corium). Neumann examined minutely a portion of the skin of a man who had partial argyria from frequent applications of nitrate to reduce large papillæ on his tongue: dark granules of the metal were found in the upper part of the cutis, in the walls of the sweat-glands, in the connective tissue of hair-follicles, in sarcolemma, neurilemma, and also in the middle coat of vessels; none were deposited in the epidermis, the mucous layer, or the epithelial lining of hair-follicles or sweat-glands (Med. Record, 1877). When the discoloration is fully developed, the skin assumes a peculiar metallic greyish-blue hue, modified in the cheeks and other vascular parts by the red colour of the subcutaneous vessels.

If the drug be stopped on the earliest appearance of affection

of the gums, the general discoloration is not likely to occur. This was shown in the case of a woman who took nitrate of silver for two months—at first $\frac{1}{8}$ gr., and later 2 gr. daily—swelling and redness of gums, with a purple line at the edges, appeared, and there was much tenderness of the mouth, but on ceasing the medicine these symptoms subsided (Bull. de Thérap., 1871). In other cases when large quantities have been taken, every part of the body has been affected. Van Geuns reports that a youth took about $\frac{1}{2}$ gr. of the nitrate daily (with occasional intervals), from his fourteenth to his nineteenth year, none afterwards; he died of phthisis at the age of thirty-five, and not only was the skin coloured, but also the cerebral and spinal membranes, the laryngeal and bronchial membranes, the peritoneum, the papillæ and Malpighian bodies of the kidney, the marrow, and the bones; the nervous and hepatic tissues, and the other parts of the renal tissue were reported normal. Heynsius concluded on analysis that the dark granules were not chloride of silver (for ammonia did not affect them), nor oxide, but minutely divided particles of the reduced metal, and this conclusion is now generally accepted (Abstract, Dub. Quart. Journ., Aug., 1858).

Charcot has recorded the presence of silver round the renal glomeruli and in the Malpighian pyramids, and Liouville has made a similar observation as to the kidneys, and also as to the choroid plexus of a patient who had taken 110 gr. in the course of nine months, three years before his death. Virchow recorded renal argyria after absorption from connective tissue. (Louisville, Ollivier, and Friedreich have stated that albuminuria may be produced by the prolonged use of silver salts.)

Argyria may follow even *local* applications of nitrate, as in the case of a girl whose throat was repeatedly cauterised—perhaps fifty times in the course of twelve months; she is said to have swallowed the products (Gaz. de Paris, xxviii., 1874). In a case recorded by Mr. Hutchinson the recent coloration could only be traced to a gargle used many years before without any such effect at the time, which seems almost incredible (B. M. J., ii., 1891). It has occurred also after tracheotomy, the wound having been pencilled “for a long time” (Dict. Encyclop. des Sci. Méd., t. vi.), and in a woman after the continued use of a nitrate pomade for dyeing the hair.

It is important to ascertain, if possible, what quantity of the drug is liable to produce coloration, and the time during which its use may be safely continued. The actual amount deposited is certainly very small: Versmann found only 0.047 per cent. in the liver in a well-marked case, but Krahmer estimated that there must be the residue of at least 1 oz. of the salt to cause discoloration; from 3 to 5 oz. are mentioned as the quantities taken in several instances, but judging from Liouville's case it is probable that less than 1 oz. might suffice, and it would be well not to exceed 300 gr. Six weeks has been named as a safe limit of time for the continued administration of the drug, and I should think it almost impossible for any ordinary dose to produce bad results within that period. Riemer relates a case of tabes in which the patient took 5,672 pills of silver nitrate, and the first traces of argyria occurred after twelve months' use of the drug, that is after 2,900 pills had been taken, which contained 1,740 gr. of silver nitrate (*Archiv für Heilk.*, 1875). Krahmer states that the minimum amount of silver which will produce argyria is 450 gr. (Husemann).

The sulphide was the salt used in the first authentic recorded case of coloration (Weigel); the iodide is said to be free from this risk, and no case has been traced to it, but Husemann considers this as accidental; the double iodide of silver and potash is also regarded as less liable to be deposited (Delioux). Once established, the discoloration is permanent.

PHYSIOLOGICAL ACTION.—*External.*—If moistened nitrate of silver be applied lightly to the skin, it combines with albuminous material, and leaves a white stain, which soon darkens on exposure to air or light, because of its reduction to metallic silver; the darkened epidermis peels off in a few days' time. A lotion which will be found useful in removing stains of silver nitrate from the hands is as follows: Iodine, 1 part; potassium iodide, 10 parts; ammonia, 1 part; and water, 100 parts (*Med. Times*, ii., 1884), but a moistened crystal of cyanide of potassium is a simpler means. Strong applications, such as the moistened stick, or solutions of 1 to 2 dr. in the ounce, cause more or less severe burning pain, and in delicate skins, vesication. On mucous membranes, or moist denuded surfaces, a whitish layer is formed by combination with chlorides and albuminous

secretion ; this layer soon becomes grey and then dark, and when it peels off may leave the part tender. Applied to a suppurating surface, the solid nitrate combines with the purulent secretions to form a greyish layer, stimulates the healing process, and causes some burning pain and redness near the part ; when the superficial eschar falls, as it does in twenty-four to forty-eight hours, fresh and healthy granulations are usually found on the wound. The action cannot extend deeply because of the pellicle which is formed, and the so-called "caustic" effect of nitrate of silver must be distinguished from that of destructive agents, such as potash or acids, for it is produced by coagulating and hardening organic tissues, rather than by destroying them. The affinity of the salt for albumin, and its forming with it an insoluble compound, explain most of the local effects of the nitrate.¹

A solution of about 20 gr. per ounce brushed over a moderately inflamed part not only discolours it, but reduces its size, controlling inflammation, and contracting the blood-vessels. Rossbach found that the local effect of silver nitrate on the bronchial mucous membrane was to make a limited patch of a white colour, over which the secretion of mucus was absent, and beneath which the vessels were probably constricted (Berl. Klin. Woch., 1882). The conjunctiva has sometimes been discoloured by the continuous use locally of medicinal drops, and in this and other very sensitive parts, such as the schneiderian, buccal, or urethral membranes, much pain, irritation, and increased secretion follow the use of strong solutions. Weak solutions (1 to 3 gr. in 1 oz.) have an astringent and slightly stimulant action, and do not cause pain except to a delicate membrane like the conjunctiva. Rosenstirn found that solutions of 1 to 10 per cent. always caused contraction of both arteries and veins within a minute after application to the frog's mesentery (Rossbach's *Pharmakolog. Untersuch.*, ii., 1876). Fikentscher obtained a similar action on the mucous membrane of the frog's tongue (Inaug. Diss. Erlangen, 1877).

¹ The chemical formula of the silver-albumin compound seems to vary under different conditions. Lassaigne gives 84.5 per cent. albumin, 15.5 of nitric oxide of silver ; Mulder, 16 of the latter in one experiment, 8.9 in another ; Krahmer, nearly 12 per cent. Delioux pointed out that the affinity of the nitrate for albumin is greater than it is for chlorine (Husemann).

Silver solutions possess also antiseptic power, in degree somewhat proportionate to their strength, and dependent in part, though not wholly, on coagulation of albumin. This property is very marked in some modern compounds (*v. p.* 441). Nitrate of silver is specially antagonistic to certain forms of vegetable growth; thus *aspergillus* will not grow in a nutrient liquid, if one-millionth part of silver nitrate be added (*Lancet*, *i.*, 1885).

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—Small doses of the oxide ($\frac{1}{4}$ to $\frac{1}{2}$ gr.), and still smaller ones of the nitrate of silver ($\frac{1}{2}$ gr.), are usually well borne by the stomach; but the latter salt produces a metallic bitter taste in the mouth, and, unless well diluted, causes burning sensations in the fauces. In $\frac{1}{2}$ to 1 gr. doses it is apt to induce nausea or vomiting, pain and diarrhœa; headache and vertigo are usual accompaniments. The long-continued use of smaller medicinal doses impairs the appetite, and may induce intestinal catarrh and hæmorrhage. Any amount over 4 or 5 gr. would be usually rejected by vomiting, otherwise it would excite inflammation. After death from toxic doses, the gastro-intestinal membrane has been found soft, eroded, or covered with grey patches. In chronic cases the muscular and mucous coats become hardened and thickened.

Nervous System.—The main point determined by modern investigation into the action of silver compounds is their special effect upon the nervous system. The best experiments have been made upon animals by hypodermic injection of hyposulphites and albuminates of silver, which do not coagulate albumin. Charcot and Ball reported, as usual results of such injection, paraplegia and paresis of pulmonary nerves, probably reflex in character, leading to profuse bronchial secretion and asphyxia (*Gaz. Méd.*, 1864). Rouget found that in mammals small doses caused excitement somewhat like strychnine; toxic doses induced convulsion and asphyxia. Batrachians got convulsions or tetanic spasm with suspension of voluntary movement, of reflex action and of respiration, whilst circulation continued; weakness, torpor, somnolence and paralysis also occurred in various degrees (*Archives de Physiol.*, 1873). Professor Curci, experimenting on animals with hypodermic injections of hyposulphite of silver,

reports that at first they stimulate sensory nerves, and through them the posterior columns of the spinal cord, so that sensibility to impressions and reflex excitability are increased—this condition extends more or less to the motor nerve tracts, muscular irritability is heightened, and tetanus may be produced; afterwards follows a secondary effect of paresis of sensory nerve centres, and of those connected with respiration; ultimately reflex action is arrested, and respiration and circulation cease. Sir W. Gowers has reported a case of argyria with paralysis of the extensor muscles of both arms, as in plumbism. We may accept these facts without assenting to the conclusions drawn by Professor Curci from them, *viz.*, that since silver compounds ultimately paralyse, they cannot be of service in paralysis, myelitis, etc., but are only indicated in spasmodic disorders, especially such as affect respiration (Med. Record, 1877).

Bogolowsky, in his experiments, sometimes found the spinal cord so far affected that the bladder became greatly distended.

An exceptional illustration of the effects of the drug on the nervous system may be found in the case of a man accustomed for twelve months to dye his hair and beard with a strong solution, who suffered from general weakness, confusion of thought, loss of memory, tinnitus aurium and defective sight, which symptoms ceased soon after stopping the dye (Bresgen, Schmidt's Jahrb., 1874, Bd. clxii.). Within my own experience I have known men suffering from giddiness, vertigo, and marked nervous depression, amounting almost to melancholia for a similar reason, and recovering quickly after ceasing the application. Convulsions occur in children after toxic doses of the nitrate, but they are probably reflex—*i.e.*, dependent upon gastric irritation (B. M. J., i. 1871).

Circulatory System.—After intravenous injections of silver salts, the blood has been found dark, pitchy, impaired as to coagulating power, and containing small crystals, and “whitish granulations,” which were supposed to be chloride of silver (Rabuteau), but are more probably derivatives of hæmoglobin (Rouget). Ecchymoses have occurred, and, together with the asphyxia and increased bronchial secretion, have been attributed to the altered chemical condition of the blood (Krahmer, Mono-

graph, 1845), but such alteration is not produced (in an acute form) by silver administered in any other way than by direct injection into the blood. Even toxic doses given in other ways do not alter it beyond some lessening in the amount of hæmoglobin and increase of fibrin (Bogolowsky, Rouget); the spectrum remains normal. But after the continuous use of full doses of albuminate or phosphate of silver, the condition of the blood becomes impaired; it is found to be thinner and darker, and tends to stagnate in, and transude through, the vessels, whilst the corpuscles part with their hæmoglobin, and become pale, transparent and angular or oval, with projections: according to Bogolowsky, they do not contain silver, as is sometimes asserted.

Sudden arrest of the heart's action, as well as asphyxia with profuse bronchial secretion, were symptoms noted by Charcot and Ball after injections of silver nitrate into the veins of animals. Rabuteau, arguing from the same results, considered the drug to be a "cardiac poison," but it is clear that when thus injected directly into the circulation the production of thrombosis or embolism may complicate and obscure the special effects of any substance. Rouget found that after hypodermic injection of toxic doses in the lower animals, the heart continued beating after respiration had ceased—*i.e.*, it was not "poisoned"; nor is there any clinical evidence of the salt depressing the circulation, unless in a secondary manner during irritant or chronic poisoning.

Respiratory System.—Orfila first described asphyxia as one of the symptoms of injecting silver nitrate into the veins, and after death he found partial consolidation of the lungs, and excessive secretion in the bronchial tubes. Several observers have corroborated these results, and it has been a question whether they are mainly mechanical from thrombosis, or the reflex effects of irritation of the lung (Charcot), or whether they are dependent upon direct irritation and paresis of the respiratory centre in the medulla, and of the neighbouring vaso-motor centre. The observations of Rouget point to the latter conclusion. He found that in most animals urgent dyspnœa occurred, and *post mortem* the lungs proved to be healthy in texture, but much contracted in volume—the muscular tissue of the bronchi being in a state of spasm similar to that seen in asthma. In adult specimens of only one order of animals

(carnivora) did he find the excessive secretion described by Orfila, and he considered that in these only were the vaso-motor centres affected. His theory that the main effect is exerted on the central rather than on peripheral nervous elements, he supported by showing that the nerves and muscles retained excitability after death. Later observations by Rozsahezzi on rabbits show that in chronic poisoning by silver there is constantly hyperæmia of the laryngeal and tracheal mucous membranes, also of the lungs, and in these organs œdema was found, with congestion, ecchymoses, effusions, cheesy masses, and sometimes a condition resembling phthisis (Archiv f. exp. Path.).

Nutrition.—Krahmer concluded from observations on himself that the silver salts lessened oxidation and excretion of urea, of uric acid, and of the watery constituents of urine; the non-nitrogenous elements were however increased, and the specific gravity rendered higher. If the administration of silver salts be continued beyond a certain point cachexia sets in, appetite and digestion are impaired, catarrh and effusions take place, the temperature is lowered, and the action of the heart and lungs weakened. The general debility and emaciation are mainly dependent upon gastric irritation, but the drug exerts a special “alterative effect” on tissue-change. Dr. H. Wood classes it with “mineral astringents,” Dr. Bartholow with “agents increasing waste,” but I think it better placed amongst those that lessen nutritive processes. Rozsahezzi demonstrated a marked diminution of tissue-change and of weight, under the continued influence of small doses of nitrate: this occurred even whilst the animal was taking a good amount of food, and when no increased excretion could account for the loss; he thinks it indirect, and due to an impaired condition of the blood and muscles. He finds (as opposed to Bogolowsky) that small doses cause a rise in temperature, but agrees with Falck that large ones lower it.

When death has followed the long-continued use of the drug, the epithelial structures, and the solid tissues generally—the liver, heart, muscles, kidneys, etc.—have been found in a state of “cloudy swelling” and fatty degeneration, and the metal has been detected in most parts of the body.

Fatal Dose (Acute Poisoning).—This varies with the gastric condition, period of vomiting and of treatment, etc.: 30 gr.

of nitrate have caused death in one case, whilst 1 oz. has failed to do so in another (that of Poumarède). Large doses have been neutralised by excess of natural mucus, or of albuminous food.

SYNERGISTS.—As regards local effects, the nitrate is allied with irritants and caustics, such as iodine and arsenic. In its general action, especially in therapeutical doses, a resemblance may also be found with these medicines as well as with compounds of chlorine, bromine, and salts of bismuth, and, in a less degree, of zinc. Some analogy with strychnine has been traced (Charcot).

ANTAGONISTS AND INCOMPATIBLES.—Sulphuric, hydrochloric, and tartaric acids and their compounds are chemically incompatible, as well as alkalies and their carbonates, astringent infusions, and lime-water; also creasote. Tannin reduces silver salts to the metallic state, with formation of gallic acid and evolution of carbonic acid. All soluble chlorides and cyanides are incompatible, since they precipitate an insoluble chloride or cyanide of silver respectively, and most natural waters do so because they contain common salt: this salt is the best antidote to poisonous doses of the drug, and should be given freely so as to cause emesis as well as to neutralise the poison.

The oxide has been given as an antidote in chronic arsenical neuritis to form an insoluble arseniate of silver, and apparently with benefit (Lancet, ii., 1890).

THERAPEUTICAL ACTION.—*External.*—Nitrate of silver may be applied either as (1) a caustic, (2) an astringent and alterative, (3) a counter-irritant, or (4) a direct irritant.

1. *Caustic.*—**Lupus.**—In cases of tuberculous and ulcerating lupus “lunar caustic” is sometimes suitable, and in the hands of Hebra, Neumann, and others, has given good results. No ordinary application or simple pencilling will be of any service, for it will not extend deeply enough, but a well-pointed “stick” should be firmly pressed into the soft tissue, in various directions and until hard tissue is met with: this is an extremely painful process, and in my experience can seldom be thoroughly done except under chloroform. As a rule, I prefer the nitrates of mercury or of zinc, but silver has the advantage sometimes where the face is affected, because its action can be so precisely limited

to the diseased part, and does not cause so marked a cicatrix. Dr. Piffard recommends fine needles to be coated with the caustic and passed into the growth, finding this to be less painful than Hebra's method. Soothing applications such as poultices and lead lotions should be made after the cauterisation, which may require repetition once or even twice weekly for some time. M. Claude specially recommends the double iodide of silver and potassium (internally) in lupus and skin disorders.

Warty Growths. — Corns, etc. — The use of the stick-nitrate for destruction of these growths is familiar in practice, and is safe and painless though not very quick in its results, for only a thin layer can be acted upon at each application: the part should be thoroughly softened and pared before the remedy is applied.

Carcinoma. — For the removal of cancerous growths, Thiersch employed injections into their substance of solutions of 1 part of nitrate in 2,000 or 3,000 parts of water, followed by a similar injection of dilute chloride of sodium (1 in 1,000); this is said to cause quick disintegration and wasting of the morbid tissue. There is some confirmation of his results, but usually suppuration and sloughing have occurred—an effect which Thiersch did not intend (*Archives Gén.*, Jan., 1867): the method has not been extensively tried.

Poisoned and Dissection Wounds. — In such wounds a liquid and penetrating caustic, like nitric acid or caustic potash, is more thorough in its effects, but nitrate of silver, being portable and at hand, has often been employed with good results; its antiseptic power is a recommendation. Mr. Youatt reports that he was bitten several times by rabid animals, and after a free use of this remedy had no ill results; but the degree of security given must vary with the thoroughness and time of the application.

Variolous and other Pustules. — Lunar caustic has proved useful sometimes in aborting purulent formations. The absence of pitting after small-pox being dependent upon the small size and limited inflammation of the pustules, Velpeau and others have endeavoured to secure such a result by puncturing the vesicle on the third or fourth day, and touching the interior with a fine point of the nitrate; if well carried out this plan has often succeeded, but it is painful, tedious and not free from danger;

the plan devised by Dr. F. Bowen is an improvement upon it, and is much more feasible, *viz.*, puncturing the vesicle with a fine needle dipped in a solution of the salt (20 gr. to 1 oz.),—a nurse can do this quite well. In one case all the parts thus treated recovered perfectly, whilst the vesicles that were untouched left deep scars (quoted by Ringer). Mr. Higginbottom recommends painting the face with the same strong solution that he used for erysipelas (80 gr. to $\frac{1}{2}$ oz.), but this is too painful for ordinary use.

Parasitic Skin Diseases.—Nitrate of silver has been employed in tinea, pityriasis versicolor, and other cutaneous affections due to parasitic growths. The rounded, white, firm tumours of molluscum contagiosum are efficiently treated by evacuating their contents and applying nitrate of silver to the interior, as above described for variola.

Chancre.—Opinions have differed as to the possibility of preventing venereal infection by applications of nitrate to the sore soon after its appearance; authorities in favour of such practice are to be found amongst earlier writers, but modern opinion is decidedly against it. Hunter, Ricord, and Acton agree in stating that if the commencing chancre, the vesicle, or pustule be thoroughly cauterised within three to five days of its origin, the cure is rapid and systemic infection very rare; but they agree also that if the sore be indurated no effect is produced, so that some of the cases they relied upon were probably soft chancres: on the other hand, Diday, Langston Parker, and others have thus destroyed chancres within a few hours of their appearance, and yet an indurated sore and secondary symptoms have followed. Cauterisation of a true Hunterian chancre at any stage will not prevent its development or the occurrence of secondary symptoms.

Early cauterisation of soft chancres will, however, sometimes cause rapid healing, and is a good treatment for sloughing or rapid spreading; but it is painful, and the sore will usually heal under simple treatment. In syphilitic ulcers of the leg I have seen solid gelatinous fungating growths well treated locally by pushing in a point of caustic and breaking them down freely with it, as already described under lupus. For syphilitic cracks, fissures and ulcers on the tongue, fauces and cheeks, the solid nitrate applied daily is useful.

Granulations.—A minor degree of the caustic action of nitrate of silver will repress exuberant granulations in wounds; they should be pencilled every day or every second day.

2. *Astringent and Alterative.*—By the latter term we mean the modifying effect exerted on tissues, especially on mucous membranes, by which an unhealthy condition usually inflammatory in its nature is subdued, and healthy action is set up in its place. Trousseau stated that this effect is due to the new agent (nitrate of silver) causing a more powerful inflammation than the original one which it displaces, afterwards itself subsiding; and this idea he developed at length under the term, “*médication irritante substitutive*” (Mat. Méd., i.), but we cannot prove the occurrence of any substitutive inflammation of this kind. We refer the effects of the remedy partly to its known physical properties of constricting vessels, of coagulating and disinfecting secretion, and of forming an adherent protective membrane; also, in certain conditions, *e.g.*, in ulceration, the vessels immediately acted on being constricted, those in the neighbourhood receive a better supply of blood, and the processes of repair are quickened.

In many forms of disorder accompanied by *discharge*, whether hæmorrhagic, mucous, serous or purulent, the nitrate, either solid or in injection or spray, is very valuable. Delioux recommends the hyposulphite of soda and silver as equally astringent and less irritant, and the same qualities are claimed for protargol and other recent combinations.

Hæmorrhage.—In cases of continued oozing from small points in the skin or mucous membranes, such as occurs after leech-bites, a finely pointed stick of nitrate firmly pressed on the part is a good astringent. In bleeding from the mucous membrane of the bladder, such as accompanies vesical tumour, injections should be made, beginning with weak solutions and increasing the strength by degrees if necessary. Mr. Christopher Heath speaks highly of this plan, and I have seen several instances of its successful use in his hands.

Chronic Cystitis.—After washing out the bladder, a solution containing 1 to 2 gr. in 1 oz. of distilled water should be injected and allowed to remain for some minutes, or until micturition occurs; this lessens the muco-purulent ropy secretion from the

vesical membrane. Mr. Reeves has used with success 20 gr. in 1 oz. (*Lancet*, i., 1853).

Gonorrhœa.—At the commencement an injection containing 30 or even 60 gr. to the ounce has sometimes succeeded in aborting the malady, but it causes severe pain, and may lead to serious inflammation. In the female a similar solution applied thoroughly, per speculum, to the vagina has given better results, and offers less risk on account of the anatomical conditions; but, as a rule, the frequent use of a weaker solution is more advisable. I recommend, as soon as the acute inflammatory stage begins to subside, an injection containing $\frac{1}{2}$ to 1 gr. in the ounce every three or four hours, or sometimes a strength of only 1 gr. in 8 oz., to be injected every half-hour for the first eight hours, and afterwards every four hours until cure is effected, which should be in twenty-four to forty-eight hours. I have had excellent results in many obstinate cases from this method; it should not be wholly omitted at the end of forty-eight hours, but used once or twice, or if the discharge continues, a little oftener for the following two or three days. Acute cases cured in twelve days by injections, once or twice daily, of solutions of 1 part in 1,000 or 2,000 of water are recorded (*B. M. J.*, ii., 1897, *Epit.*). Argyrol in solution of 2 to 5 per cent. is said to act even better.

Balanitis.—Gonorrhœal inflammation of the glans penis is effectually treated by the frequent use of a weak lotion (1 gr. in 1 oz.) in addition to light pencilling with the solid stick.

Spermatorrhœa.—The treatment by local application of a strong solution to the prostatic urethra in the neighbourhood of the openings of the seminal ducts was strongly commended by Lallemand, but his statements are exaggerated; it is useful sometimes, and was markedly so in the hands of Dr. Dawson (*On Spermatorrhœa*), but it should not be employed without due consideration. I have seen serious consequences follow it.

Leucorrhœa.—Injections of silver nitrate have been found effectual in the vaginal form of this disorder, the strength of application being proportioned to the duration of the malady: a drawback to its use is the staining of linen. (There are several varieties of leucorrhœa, and each must be treated on its own merits, as some will require internal remedies as well as injections—the checking of discharge by this or other astringents is only one part of successful treatment.)

In *uterine leucorrhœa* the discharge is glairy and stiffens the linen, and is accompanied with distinct suffering. It is usually connected with cervicitis or endometritis, and in chronic stages, especially when the os uteri is patulous, solutions, and even the solid nitrate, have been passed into the uterine cavity with good result (Dr. Henry Bennet): this, however, has led to some abuse of the remedy, and I have seen painful symptoms connected with induration of the cervix and narrowing of the canal as a consequence of too prolonged a course of cauterisation.

Granular Erosion of Cervix.—The nitrate has been much used in this condition, but the solid salt can exercise only a limited influence. In chronic cases, where the part is enlarged, and the epithelium so long absent that the bared villi resemble granulations, I have found benefit from recently prepared iodide of silver, as recommended by Dr. Henry Wright. To a little of the strong silver solution (3j in 3j) a few drops of tincture of iodine are added, and the iodide of silver precipitates at once in white flakes, which should be quickly applied—through the speculum. All mechanical causes of erosion of the cervix must be considered, and, if present, treated at the same time.

Real *ulceration* of the cervix, as distinguished from erosion, is usually connected with syphilis, tubercle or malignant disease, and although the nitrate has been often used for it, more potent remedies, such as the acid nitrate of mercury, are really required.

Ulceration.—When an ordinary ulcerated surface is discharging freely, a lotion of moderate strength is usually more suitable than the solid nitrate, because it does not involve confinement of discharge under a limiting membrane (though, indeed, such membrane may be punctured if necessary).

The best use of the solid stick is made in indolent ulcers with pale small granulations, and but slight discharge. The remedy should be lightly applied over the central parts, avoiding the new tissue at the margins, and under this stimulus and the protection of the film which is formed, healing will be much quickened. The brittle stick nitrate is superior to the prepared points of “lunar caustic,” for it is more soluble. Cuthill insists on the importance of stimulating an ulcer rather by dots and lines of silver nitrate than by coating its whole surface, better exit for discharge being thus given (Edin. Med. Journ., 1877). Crede

(Berl. Klin. Woch., 1896) and Werler (Dermatol. Ztschft., 1897, etc.) have both written forcibly in favour of silver salts in the antiseptic treatment of wounds — small ones were covered with silver foil, large ones with silver gauze or dusted over with the citrate powder and protected from air; they found silver a more active germicide than corrosive sublimate. Protargol is used in the same manner.

Purulent Ophthalmia.—In the ophthalmia of new-born children, and also in the epidemic and the gonorrhœal forms of the disorder, solutions of nitrate are extremely valuable, though they often cause severe pain for a time. The lids should be separated and the eye cleansed by a stream of tepid water, and in acute not very severe cases a few drops of a solution (2 to 5 gr. in 1 oz.) should be instilled—in very severe cases with chemosis, a strength of 20 or 30 gr. in the ounce may be employed once or twice daily, but should be followed by a syringeful of plain water, or of weak salt solution, in order to neutralise any excess of nitrate. In chronic cases, especially when scrofulous in character, with thickened conjunctiva, photophobia, lachrymation, etc., the solid stick may be lightly used to the lids with advantage; but in all cases the liability to discoloration must be remembered, and the remedy must not be used too often or too long; when ulceration is present, or the membrane not entire, other remedies should be preferred. Catarrh and conjunctivitis have followed the use of a 2 per cent. solution (Lancet, i., 1900). Protargol is recommended (*ib.*, i., 1898), and argyrol in solution of 10 to 25 per cent. is largely used abroad.

Otorrhœa, with perforation of the membrane and with tendency to formation of polypus, is best treated by touching the tympanic mucosa with a concentrated solution of the nitrate; the discharge should be daily removed by ordinary antiseptic lotion.

Ozæna.—**Coryza.**—In chronic nasal discharges if the bones be not seriously affected, and in ordinary coryza, benefit may be derived from injections of nitrate of silver (2 to 5 gr. in 1 oz.). In the former condition, a cleansing and disinfectant nasal douche should first be used, and afterwards the astringent should be injected from behind forwards by means of a curved tube passed to the back of the fauces, and connected with a rubber ball. Powdered nitrate has been insufflated in antral empyema.

Nitrate of silver in various forms is an important agent in the treatment of diseases of the *throat and air passages*, but its strong caustic action is invoked much less frequently now than formerly; we require rather the astringent or alterative action to relieve congested, or brace relaxed parts. Dawosky concludes, after extensive experience, that whenever local applications are required for congested mucous membranes, nitrate of silver gives the best results; besides its chemical influence, it stimulates the congested vessels to contract and get rid of their excess of blood. For congested conditions of the fauces with adherent secretion and patches of redness and swelling, he recommends a strength of 1 part in 8 (Med. Record, March, 1878), but I think it better to *begin* with half this proportion.

Tonsillitis.—In the early stage of this inflammation—it must be at least before suppuration has set in—a strong solution (30 to 60 gr. to 1 oz.) applied once in twenty-four hours will sometimes abort further progress. Judgment is required to determine the suitability of cases for this treatment, for if the inflammation be very acute, irritant applications may increase it. In sloughing ulceration about the fauces, strong nitrate solutions are sometimes serviceable, and are better than the solid caustic; but more active disinfectants, such as iodine or carbolic acid, are still better. In chronic enlargement of the tonsils, the occasional application of a finely pointed stick of nitrate of silver thrust well into the substance of the enlarged gland causes cicatricial contraction and diminution of size. A case in which the stick was swallowed accidentally is recorded in *Lancet*, i., 1897. The temperature became at once subnormal (shock?). The patient, a medical man, recovered.

Diphtheria.—In diphtherial inflammation with membranous deposit, I cannot recommend the strong nitrate; if the part be irritated it is more liable to inflame, and if the membrane be roughly detached the absorbents more readily receive morbid material, so that although this remedy was at one time commended, I am satisfied that the use of a solvent or disinfectant spray is more serviceable, and is far more thoroughly and easily effected. Strong nitrate of silver is not a suitable local remedy for membranous croup (laryngeal diphtheria), or *acute* congestion of the larynx. I have seen almost fatal suffocative spasm of the

vocal cords induced by the application of the solid nitrate in the latter condition. Guillon, however, states that the insufflation of finely powdered nitrate may be very useful (Med. Record, 1877); sometimes a weak spray (1 gr. to 1 oz.) has been of service. Dr. Gibson recommends the inhalation of air from a bottle with a quantity of powdered silver nitrate at the bottom of it; this should be diluted with dried starch, tragacanth or lycopodium, in the proportion of 1 gr. of silver nitrate to 19 of the diluent (Lancet, i., 1882).

Œdema Glottidis—Chronic Congestion.—This severe form of œdema is sometimes quite controlled by strong silver nitrate solutions, which may obviate the necessity for scarification or more serious procedures. In *chronic* laryngeal and faucial congestion, a curved brush carrying a solution of 20 to 30 gr. to the ounce may be applied with the help of a mirror to the exact part affected, and with very good result. Dr. Horace Green and Professor Hughes Bennett were early advocates of this method of treatment. Many surgeons, however, now prefer solutions of copper, zinc or iron, as causing less irritation, and less risk of subsequent contraction, than the silver salt. A *weak* spray is of very little service in these conditions, and the use of the brush has largely superseded the method of insufflation which was approved by Troussseau. He used 3 gr. of the nitrate mixed in fine powder with 60 gr. of sugar of milk, and this was blown into the patient's mouth during a deep inspiration, by which some of it was carried into the larynx.

Laryngeal Phthisis.—The solution is, according to my own experience, of much service in the early stage of this disease, and was recommended by Hughes Bennett, Marcet, and others, but objected to by L. Thomas (B. M. J., i., 1878); lactic acid or menthol are now generally preferred.

Relaxed Throat, etc.—It is in chronic relaxed conditions of the fauces and pharynx, with dysphagia and constant discomfort, aching in the throat, cough and hawking of phlegm, that the remedy gives most relief. There is no acute inflammation present, and the affected parts are either pale with prominent follicles, or swollen and of purplish colour, with more or less viscid, yellowish secretion. In "clergyman's sore throat" the follicles of the pharynx are mainly affected, and in all these

cases a solution of 20 gr. to the ounce, with glycerin, should be applied once daily or on alternate days, whilst tannin, borax, etc., are used in the intervals.

In *aphonia* connected with local debility and relaxation, silver applications relieve by their astringent tonic action, and in hysterical aphonia the irritation excited is often sufficient to restore the voice. Relief may also be given to obstinate *coughs* arising from relaxed faucial conditions, and not amenable to internal remedies, by a solution containing about 5 to 10 gr. in the ounce, applied once or twice daily.

Chronic Bronchitis.—In cases accompanied with profuse muco-purulent discharge, I have often proved the efficacy of a spray containing nitrate of silver. I use only weak solutions—from 1 to 4 gr. in the ounce—and find that they alter and restrain the secretion in a very satisfactory manner.

Erysipelas.—The power of the remedy in this disease depends much on the mode of its application; the mere drawing of a line of caustic round the inflamed margin (as sometimes practised) is illusory. The best method is that of Mr. Higginbottom, who advises previous cleansing of the part with soap and water, then with pure water, and afterwards the thorough application of a saturated solution (20 gr. in each fluid drachm) two or three times over the whole affected surface, and beyond it on the healthy skin for about two inches. This is effective in the superficial forms of erysipelas, but not, according to my experience, when much œdema or cellulitis are present, and I am reluctant to advise it over an extensive surface, or in the idiopathic form. It causes severe burning pain, and in the latter condition at least, does not always stay the inflammation, so that I prefer milder applications and appropriate internal medication. Crede asserts that the disorder may be at once controlled by hypodermic injections of the citrate. An ointment containing 15 per cent. of the silver in a colloid state—known as Crede's ointment—used by inunction is said to benefit this and indeed all septic conditions (Werler, *Internat. Journ. Surgery*, N.Y., Dec., 1898).

Whitlow.—Furuncle.—Erythema.—These conditions are sometimes advantageously treated by the method of Higginbottom, but the solution may be made weaker, and nitrous

ether employed as the vehicle; it does not dissolve so much as water, but 30 to 40 gr. in the ounce will be strong enough; this should be painted over the affected finger, or the commencing boil, or the inflamed and irritable patch, but practically carbolic acid has superseded it. Chilblains are relieved by the nitrate, and it is said to prevent a threatened eruption of herpes if used early enough. To *bedsores*, in any stage, a solution of 5 to 10 gr. in the ounce may be applied with advantage.

Eczema.—The use of strong nitrate of silver in eczema should be reserved for chronic patches with much infiltration. Nitrous ether proves the best vehicle, because it dissolves sebaceous or fatty secretions, and allows the remedy to act better on the distended capillaries—30 to 40 gr. in the ounce may be used. Eczema in the neighbourhood of ulceration yields to lotions of moderate strength. For eczematous or aphthous conditions affecting the genital organs or the nipple, and commonly accompanied by severe itching and irritation, a solution containing 4 or 5 gr. in the ounce should be first used in cases that are somewhat acute; but if relief be not given, a paint containing 30 to 40 gr. in the ounce should be carefully and lightly brushed over the part; a strength between these is serviceable for subacute patches with some weeping, which are slow to heal. Quite the best treatment for fissured nipples is to touch them thoroughly but lightly with a fine point of nitrate: all secretion should be cleansed from the part before such applications, and warm fomentations should be ready for use afterwards, as the pain may be severe. In abrasions or aphthous conditions about the mouth, the solid nitrate is one of the best remedies, although a painful one.

Burns and Scalds.—In superficial burns the strong solution has been applied, and to deeper injuries when the true skin is affected the solid stick has been used with the object both of forming a covering from air, and of lessening the degree of cicatrisation (Fricke). This method has not met with general support, but a modified plan was recommended by Mr. Skey, who used a lotion containing about 6 gr. in 1 oz. for infants, and twice that strength for adults, covering the part immediately afterwards with cotton wool (Lancet, ii., 1861). A mixture with linseed oil has been commended (Wernher), and the solid stick

is always useful in later stages when ulcerations are slow to heal. Hebra applied it once or twice daily, especially where there was liability to adhesions.

3. *Counter-irritant*.—The action of the remedy when applied locally in superficial inflammations has earned for it the title of “caustique antiphlogistique,” but we cannot recognise in it any distinctly caustic action, any more than we can verify the production of a “substitutive inflammation,” which replaces for a time the original malady, and then itself subsides. The main factor in the result is an astringent effect on the vessels and nutritive processes, but there are cases in which, when the nitrate is applied to some other than the affected part, it will relieve by an action which may properly be called counter-irritant or derivative, the “*médication irritante transpositive*” of Trousseau. Thus, Liston and Elliotson treated erysipelas by its application to the neighbouring *sound* skin, and Lubanski, Egan and others treated amenorrhœa by pencilling the os uteri (Dub. Journ., 1848).

Orchitis.—Synovitis.—In these deeper-seated inflammations, benefit may be obtained from strong nitrate of silver applied on the principle of counter-irritation. The best position for the application has been much discussed, some placing it as near the part as possible, others insisting that it shall be between the heart and the inflamed tissue, and others that it shall affect vessels which receive their supply from a different source than the affected part. The simple rule adopted by Mr. F. Jordan, with much success, is to apply the nitrate over the *adjacent vascular territory*; thus, in orchitis he applies it over the great vessels in the groin and front of the thigh (Pract., vol. ii.). In synovitis it is used round the affected joint, though iodine is usually preferred in this disorder. It is probable, however, that the sensory skin fields corresponding with the deep-seated organ affected is the great objective of such methods.

In irritation of the *prostate gland or seminal ducts*, it may be applied to the perineum, rather than to the urethral membrane itself.

4. As a *direct irritant* (the “*médication excitative*” of Trousseau) the nitrate finds some applications.

Hydrocele.—The solid stick may be applied, for instance, to the interior of a hydrocele sac after evacuating the contents,

but an injection through a trocar is more under control: the object is to excite sufficient inflammation to induce adhesion; this is now better effected by iodine.

In **Sciatica** of chronic and obstinate character, 10 to 20 drops of the solution injected deeply near the seat of pain will lead to a localised inflammation which sometimes cures the original malady: it is best used in the nates at the point of emergence of the sciatic nerve.

In other chronic obstinate neuralgiæ, or indeed in any deep-seated neuralgic pain of any part, Le Dentu injects deep into the cellular tissue 2 or 3 drops of a solution containing 1 part of silver nitrate in 5 of water: this causes acute pain for the moment, and sometimes a small abscess afterwards, but never serious trouble (Med. Record, 1877). Dureau (Thèse, Paris, 1877) sums up very favourably the experience recorded of this method of treatment; it is said to be both certain and rapid in its effects, and not to cause much irritation of the deep tissues. Luton used a 10 per cent., also a 5 per cent. solution, and others one of 25 per cent., injecting 5 min.—all with successful results (Record, 1882)—but chloroform is now generally preferred for use in a similar manner.

In **Chronic Joint Disease, Synovitis**, etc., equally good results have been recorded from the method of Luton—*i.e.*, deep injections into the joint-cavity (Med. Record, 1877). The process may be compared with that of Thiersch for cancer, in which weak solutions only are used, and suppuration is not intended.

THERAPEUTICAL ACTION.—*Internal.*—The value of silver compounds is acknowledged in certain disorders of the gastro-intestinal mucous membrane, and of the central nervous system. In the former their action is a local one, doubtless of the same character as that exerted upon the external surface; in the latter they are given for a “constitutional” effect of tonic or indirectly sedative character.

Dyspepsia.—**Chronic Gastritis and Gastric Catarrh.**—The nitrate and the oxide are both valuable in many of these cases, and in judging of their suitability in a given instance, it is not easy, nor is it essential, to draw a definite line between functional and organic disorder. Gastric pain, especially when severe and coming on some time after food, with tenderness,

distension, pyrosis and vomiting, are sufficient indications. Dr. J. Johnson, one of the earliest observers of this use of the nitrate, found that mental depression, or motor disturbance of convulsive character, furnished additional indications for it (On Indigestion, 1826). Dr. Symonds recommended it "in nervous irritability with passive or chronic congestion of the stomach." In Dr. Hudson's cases, pain of very acute character and long duration, with distension, thirst, constipation and vomiting of sour fluid, were relieved within one or two weeks, but he gave the remedy ($\frac{1}{4}$ gr. doses) with opium ($\frac{1}{4}$ gr.) and hop (Dub. Journ., 1840). Dr. Osborne, a distinguished Dublin physician, found it valuable in gastralgia with "sour vomiting" (1831), and more recently we find Dr. Spender praising it as the "best remedy in pyrosis" (Pract., 1868), and Dr. H. Wood "in vomiting of much yeasty fluid." I should attribute importance to its disinfecting properties in such cases. Dr. Wilson Fox added his testimony to the "well-established reputation of the silver salts in chronic gastric catarrh," and placed them next to bismuth: he would generally prescribe them however with opium, whilst Frerichs, also a high authority, gave them with belladonna. The absence or the presence of constipation will be a useful guide to the choice of these adjuvants. In gastritis Dr. A. Fleming obtained good results from the nitrate, and his mode of using it would seem to obviate, if that be necessary, the objection urged by Brinton, and to some extent by Husemann, *viz.*, that the smallness of the dose and the dilution and chemical change of the drug must make it almost inert. He was accustomed to order $\frac{1}{2}$ oz. only of distilled water containing from 1 to 4 gr. of the salt, to be taken fasting, and in the recumbent position, the patient then to turn himself from side to side so as to ensure contact of the remedy with different parts of the stomach wall; in some cases he even injected the dose directly into the viscus with a syringe and perforated tube (Med. Times, i., 1859). Dr. Hartshorn valued the nitrate in chronic gastritis, and gave it in pill (Amer. Journ., 1849). My own use of the remedy has been generally in doses of $\frac{1}{16}$ to $\frac{1}{4}$ gr. every four or six hours in distilled water, and I have observed from it much relief [of discomfort and pain, flatulence, heartburn and pyrosis, yet there is some uncertainty in its action. Women suffering from the above symptoms, to-

gether with severe retching and vomiting of tenacious fluid, and a too frequent and profuse menstruation, are almost always relieved by it, but the maladies in question assume so many phases, and are more or less amenable to so many forms of treatment that we cannot be surprised at difference of opinion as to the true value of this.

It has naturally been thought that risk of caustic and irritant effects might be obviated, and equally good curative effects obtained by the use of the oxide of silver instead of the nitrate, and this was brought prominently before the profession by Mr. Lane (Med.-Chir. Rev., 1840-41), and afterwards, in a special treatise, by Sir James Eyre. The former records a number of cases with severe but intermittent gastrodynia, general uneasiness, nausea, and watery eructation, almost all relieved quickly by $\frac{1}{4}$ or $\frac{1}{2}$ gr. doses of the oxide: nothing is said about diet or other adjuvant treatment. Mr. Lane states further, that if organic mischief have resulted—if the tongue be tumid and cracked, and the pain constant, or the ejected fluid “glairy” (as in Todd’s “follicular gastric dyspepsia”), then the remedy is of no service; but it is not necessary to adopt these limitations if other indications for the remedy exist.

Uterine Disorders.—Dr. Hudson and others remarked the great improvement in certain uterine symptoms during the exhibition of silver-compounds, and recorded cure of many cases of menorrhagia, of uterine leucorrhœa, and of painful menstruation, though not with the scientific precision now expected. Many cases occurred at the menopause, some during pregnancy, and in several a previous long sterility was followed by fecundation: simple vaginal leucorrhœa was not benefited.

On these lines I have prescribed the oxide for nervous, highly sensitive women suffering from gastrodynia and pyrosis, with coincident uterine flux, and have often seen marked and immediate improvement in both symptoms, and without any drawback. The use of the medicine need not however be restricted to such cases; its action is somewhat similar to that of bismuth, and it may be used if that should fail to relieve. It has the advantage of being effective in a much smaller dose: $\frac{1}{10}$ to $\frac{1}{2}$ gr. is usually quite sufficient, and in the form of a minute pill this is readily taken. I have not seen the irritation from it which has sometimes been

described, nor the salivation which might be produced by its too-prolonged use, nor any symptoms of argyria ; it should not, however, be continued for many weeks consecutively. It is useful for cases in which arsenic also relieves, and an interesting fact is that this remedy and bismuth have often an equally good influence over uterine hæmorrhage when connected or coincident with gastric disorder.

In the *cardialgia and vomiting of pregnancy* I have found it useful when many other remedies failed to give relief.

Gastric Ulcer.—In so serious an organic disease it is not surprising if the powers of the silver compounds have been called in question. Cases of marked relief, if not cure, by these remedies have however been recorded (Stillé), and it seems reasonable to allow that if they can relieve ordinary gastritis, they may relieve the same condition when dependent on a local lesion ; they lessen local congestion and local irritation of the gastric nerves, and in some cases, at least, form a protective layer of albuminate, and probably thus relieve the pain.

Chronic Diarrhœa.—Dysentery.—I have seen great benefit from nitrate and oxide of silver in many forms of these disorders—in serous diarrhœa, in chronic and periodic forms, in diarrhœa after fever, and in that of dysenteric character.

Graves preferred the nitrate (which he gave in grain doses) to any other astringent or to opium, but he avoided it in cases of ulceration, in which really its advantages may best be proved. Dr. J. MacGregor reports several cases of exhausting diarrhœa during advanced phthisis, in which the relief was marked and immediate ; he gave the remedy also in 1 gr. doses with $\frac{1}{4}$ gr. of opium, and in enema (Brit. and For. Rev., Sept., 1841). I have often found it of the greatest advantage in such cases, restraining the profuse discharge, and aiding to strengthen the patient ; I have given from $\frac{1}{10}$ to 1 gr. In the form of enema, containing 3 to 4 gr. in 2 oz. of distilled water, it is a valuable remedy for chronic dysentery and ulcerative conditions of the rectum ; the enema should be slowly injected and repeated every six to twelve hours for three or four times, if necessary. If all or the greater part of the enema be not returned, another enema containing sodium chloride may be desirable. The slow injection of copious enemata—3 pints containing from 45 to 60 gr. of the salt—is a valuable resource in obstinate cases (Lancet, i.-ii., 1882). I

have often tried this with success: any after-pain or tenesmus—which is not uncommon—may be relieved by opium, and it is well to inject some weak sodium chloride solution. If ulceration or congestion be situated higher up in the intestine, the nitrate is best given by the mouth in pill, since it is thus most likely to reach the affected part unaltered, and to exert the local action which is desired. The chloride of silver has also been used with advantage in chronic dysentery.

In the diarrhœa of children, the nitrate has been recommended by Trousseau, Mauthner, etc. I do not think it advisable for acute cases, for it is uncertain in action, but in prolonged and obstinate cases a few doses often act well; they may be given by the mouth or rectum.

Typhoid Fever.—Dr. Pepper has recorded fifty cases in which, after the second week, the medicinal treatment was nitrate of silver ($\frac{1}{4}$ gr.), with small quantities of belladonna and opium; only one case was fatal, and he considers that these remedies act favourably by limiting follicular catarrh and modifying its secondary effects (Boston Journ., 1877).

Nervous Diseases—Epilepsy.—It is curious that silver was early appropriated to the treatment of cerebral disorders by the theories of astrology, which associated both the metal and the malady with the influence of the moon: by the time of Linnæus its medicinal virtues were so far distrusted that he describes only its “power as political, its use commercial.” It retained, however, some reputation in epilepsy, and of late years there has been further evidence of a neuro-tonic power exerted by it rather upon the spinal than the cerebral nervous system, as illustrated in some forms of paralysis.

Unless we are wholly to reject past records, and the opinion of distinguished physicians, the nitrate has given good results in a large number of epileptic cases. Heim considered it the best of remedies, and Trousseau who used also the chloride, places the silver salts second only to belladonna. We should not, with Krahmer, consider it most suited for the robust, but rather for the delicate with a morbidly irritable and susceptible nervous system, and a languid state of the organic functions (Stillé); it is in the pallid and anæmic that strychnine acts well sometimes (Tyrrell), and it is in similar cases that I should

be hopeful of good results from silver. Definite indications we cannot at present lay down, and must acknowledge that of any given number of cases the majority at least will not yield to this remedy, and others, if they receive temporary benefit in the prolonging of the interval or lessened severity of the attacks, will ultimately relapse. The greatest objection to nitrate of silver, and one which has led to its comparative disuse, is the possibility of its discolouring the patient, and this even without curing his malady,—I have seen epileptics discoloured by the medicine, and yet suffering as severely as ever from their convulsions. Unfortunately the nature of the disease requires a long continuance of treatment, and therefore a medicine must be preferred which shall at least not inflict so visible an injury, and we need seldom prescribe the silver salt until a fair trial has been made of bromides, belladonna, etc. If however it be decided upon, then a purgative should be given at the commencement of, and occasionally during, treatment; the remedy should be omitted for a few days at intervals, and the gums should be carefully watched for signs of systemic saturation. The use of nitrate for *epilepsy in children* has been objected to by Löbenstein, but I have seen it of service in chronic cases. Brenner recommends the chloride in infantile convulsions, and also in the brain-affections of typhus. Niemann found advantage from the ammonio-chloride in epilepsy and melancholia.

Locomotor Ataxia.—We cannot speak with any confidence of the power of silver compounds to relieve serious or chronic cases of this kind, though there are not wanting records of improvement, more or less marked, obtained under their use. Wunderlich reported seven cases of ataxy arrested under 5 gr. doses, given two or three times daily; whilst Charcot and Vulpian related five cases that had lasted respectively two, four, five, and two of them fifteen years. A pill containing $\frac{1}{4}$ to $\frac{3}{4}$ gr. of nitrate was given daily for from thirty-five to sixty days, and in every case in the course of a week improvement commenced as to sensibility, power of placing the limbs, as to sight, and especially as to lessening of pain (*Mémoire sur le Nitrate*, Bull de Thérap., 1862). The report of such cases caused much sensation, but Topinard, who criticises them closely, asserts that in some the diagnosis was imperfect, and that, admitting it in the

others to be correct, there were unsuccessful cases to be compared with them, and many others unrecorded (De l'Ataxie Locomotrice, Paris, 1864). He collected altogether twenty-eight cases, more or less favourable to the efficacy of the nitrate, and nine unfavourable; to these, he has added seventeen cases carefully noted under his own observation; commencing with $1\frac{1}{2}$ gr. daily, he continued it for ninety days, interrupting the course every eight days for a week; then, $\frac{1}{6}$ gr. was given for four months. In the first case reported no good result was obtained, though erections recurred; at the end of the treatment the patient was worse, and the same had to be said of eleven other cases: in the remaining five there was some amelioration of symptoms. Althaus, on the other hand, had on the whole a favourable experience with this remedy, and I believe that I have seen benefit from it in relieving the "lightning pains," and in arresting, for some time at least, disorder that was progressing, but it is no specific against locomotor ataxy.

Diphtherial and Mercurial Palsy.—A case of the former kind, supposed to have been cured under the use of nitrate, is recorded (Amer. Journ. Med. Sci., 1865), but I am not aware of others. Fairly rapid recovery in six instances of mercurial palsy is reported by Sementini with doses of from $\frac{1}{8}$ to 3 gr. daily. In a case of arsenical neuritis, Dr. Barton gave 2 gr. of oxide of silver thrice daily with rapid improvement; he calculated it should form a soluble arseniate (Lancet, ii., 1890). It is probable, however, that all the improvement was independent of the treatment.

Nervous Debility.—Headache.—In some few cases of nervous debility and depression connected with overwork, anxiety or excess, and exhibiting hypochondriacal symptoms—morbid fear, impaired mental capacity, and frequently rather deep-seated fixed headache—I have seen improvement under the use of nitrate, and have felt justified in connecting it with this drug, because iron and bromides and other remedies had been used without advantage, and the patient's mode of life and circumstances were not altered when the silver was commenced.

In *hysterical* or *nervous* headache it was valued by Dr. Graves, and others have found it useful in neuralgia, for which Paterson recommends especially the iodide. If the headache be accom-

panied with constipation or gastric disorder, an occasional laxative is required.

Various Diseases.—Other disorders which may either be called “nervous” in character, or are connected at least with reflex nerve-disorder, and which the salts of silver have been found sometimes to relieve, are such as *chorea*, *angina pectoris* (Copland, Dict.), *spasmodic asthma* (Waring, Curci), *palpitation* (Kopp), *vertigo* (Redemachar), *pertussis* (Berger): for this last the iodide is especially recommended. They have been given also in more general diseases, as *intermittents* (Sokolow), *phthisis* and *diabetes* (Brady, Moore), the object desired in these latter cases being mainly to lessen the excessive discharges from the kidneys, the skin and the bowels; in some instances they have certainly succeeded, though we could not expect them to alter the ultimate termination of such maladies. Of upwards of sixty cases of *pneumonia* treated by small quantities of nitrate, 5 to 15 milligrams per diem, given in ten doses, the majority made good recoveries—it is especially noted that the crises occurred early, in two or three days, with fall of pulse and temperature, though local physical signs continued (B. M. J., i., 1898 and 1900, Epit.). In *dropsy* the nitrate was given by Boerhaave as a purgative in 2 gr. doses, and has been more lately commended by Dreyer (Husemann). In *syphilis* the chloride and oxide were given by Serres and others, but their value was disproved by Ricord. The ammonio-chloride has been used as a cathartic and vermifuge.

PREPARATIONS AND DOSE.—*Argenti nitras*: dose, $\frac{1}{4}$ to $\frac{1}{2}$ gr. (B.P.); it may vary from $\frac{1}{20}$ to $\frac{1}{2}$ gr., and more has been sometimes prescribed. *Argenti nitras induratus*. *Argenti nitras mitigatus*. *Argenti oxidum*: dose, $\frac{1}{2}$ to 2 gr. in the form of pill. (See also p. 440.)

The dose of the *chloride* is about the same as that of the oxide, though upwards of 30 gr. have been given without gastric pain (Trousseau); the dose of *iodide* and other salts is also about the same as the oxide.

As a caustic the solid nitrate may be used alone, or “mitigated” with nitrate of potassium. In default of a metal, or vulcanite or quill holder, melted sealing-wax forms a convenient coating, and a file, or friction with wet lint, sharpens the point better than a knife: for small fistulæ or numerous leech-bites a silver probe, dipped as required in the melted salt, or made red-hot in a spirit lamp and then dipped into the powdered nitrate, is convenient. The finely powdered nitrate, diluted (with sugar for

example), has been used for the throat and larynx, and abroad, charpie dipped in a strong solution and dried is used as a dressing for indolent wounds, and known as the black or caustic charpie of Riboli (Husemann).

Of solutions, 40 gr. in the ounce will prove *caustic* to mucous membranes, and from 80 gr. upwards, caustic to the skin; distilled water, glycerin, or nitrous ether may be used as solvents; after a strong application the part, especially if it be the eye, should be bathed with warm salt water to neutralise any excess of caustic—20 gr. to the ounce is a useful strength for an *astringent* solution, but a proportion of 10, 5, and even 1 gr. to the ounce is suitable, according to the condition of the affected part, and may be used in lotion, injection or collyrium, as already described, it being remembered that the weaker solutions require to be used the more frequently: the disadvantage of the salt staining linen must be borne in mind.

Both the nitrate and oxide have been used in stimulating and astringent ointments: thus, in the Hamburg Pharm., 15 gr. are ordered with 1 dr. of Peruvian balsam and $\frac{1}{2}$ oz. of zinc ointment (Ungt. Nigrum), and Lane used the oxide in specific and other ulceration, but I do not think ointments a good form in which to exhibit this remedy.

Since the salts of silver are readily decomposed, they should be mixed as little as possible with organic or mineral substances, and haloids, sulphides, alkalies, soaps, tannin and astringent extracts should be excluded from prescriptions for silver compounds: it is important to mention also the exclusion of creasote, for explosions have occurred from its trituration with oxide of silver and organic substances, oxygen being liberated. Solutions of the nitrate for internal use should be kept as much as possible from air and light, and are therefore commonly ordered in covered or dark-glass bottles: they may be made with distilled water or with glycerin, and sometimes a few drops of nitric acid are added to prevent reduction; syrup may be given with it for children. Delioux prescribed it with an equal part of salt in a weak, sweet, albuminous solution (white of egg), and Deniau added to this a small proportion of bromide of potassium to re-dissolve the precipitate; but in such combinations, the object of which is to secure solubility and absorption, we are not giving

the nitrate, but a complex chloro-albuminate. Discoloration of the lips and teeth, and nauseous taste, are drawbacks to the use of any solutions. A pill may be made with crumb of bread according to an old and well-known formula (Boudin): the decomposition into chloride that may occur is unimportant, but argilla, silica, kaolin and chocolate have been recommended as vehicles, in order to avoid it. The oxide is always given in pill or confection, and this form is to be preferred for "constitutional" effects, or for an action on the lower parts of the intestinal tract. It is usual to direct a patient taking these medicines to abstain from much salted food before or after the dose, as likely to hinder absorption into the blood.

ARSENICUM—ARSENIC, As = 75 (74·50).

The name arsenic is applied by common usage both to the element and to its *trioxide*, which is more correctly termed arsenious anhydride; it is also called white arsenic, or arsenious acid.

The element occurs sometimes native, but generally in alloy with iron, copper and other metals, as oxide and sulphide. Nearly all sulphur contains some arsenic, and from these different compounds it is liable to pass undesignedly into many preparations. Mineral waters also frequently contain traces of it; Tripier has noted its almost constant occurrence in chalybeate, and Trénard in saline springs, though in minute proportion: those of Plombières contain but 0·0008 gr., Vichy 0·01 gr., and La Bourboule (the largest amount) $\frac{1}{16}$ gr. in 16 oz. Royat also contains it, and the Madeleine spring of Mont Dore is strongly arsenical; Bath waters also contain it. The strong Levico water (South Tyrol) has $\frac{1}{12}$ gr. per pint, with iron 30 gr.

CHARACTERS.—The metalloid is a steel-grey solid of metallic brilliancy, readily oxidising and tarnishing on exposure to air; it volatilises at a dull heat, the colourless vapour having a garlic-like odour; it burns when heated in the air.

ACIDUM ARSENIOSUM—ARSENIOUS ACID, OR ARSENIOUS ANHYDRIDE—WHITE ARSENIC ($\text{As}_4\text{O}_6 = 396$).

CHARACTERS.—Occurs in heavy white powder, or stratified opaque white pieces. The powder is not readily wetted by water, so that it is apt to remain floating on the surface or adherent to the sides of a vessel. Solubility, 1 in 100 of cold, 1 in 10 of boiling water. Organic products, milk or mucus, render it *less*, acids and alkalies *more* soluble; oils and alcohol also dissolve it. It crystallises from a saturated solution, or after slow sublimation, in minute shining octahedra, or in rhombic prisms (like oxide of antimony, with which it is isomorphous): sprinkled on a red-hot surface it evolves scarcely visible vapours of metallic arsenic, which have an odour like garlic, and at a few inches from the hot surface change to dense white odourless smoke, being the acid re-formed by oxidation. Arsenious acid itself has no smell; its taste is sharp and rather nauseating (Hirtz), but in such small quantities as may be taken for trial nothing more than a slight sweetness and grittiness will be detected (Christison).

LIQUOR ARSENICALIS—ARSENICAL SOLUTION—FOWLER'S SOLUTION.

CHARACTERS.—A reddish, alkaline liquid, with the odour of lavender, of which it contains the tincture with an alkaline solution of arsenious acid, 1 gr. in 110 minims (1 p. c.).

LIQUOR ARSENICI HYDROCHLORICUS—HYDROCHLORIC SOLUTION OF ARSENIC.

CHARACTERS.—A colourless liquid of acid reaction and sp. gr. 1.010.

ARSENII IODIDUM—ARSENIOUS IODIDE ($\text{AsI}_3 = 456$).

CHARACTERS AND TESTS.—It occurs in small orange-coloured crystals, which are readily soluble in water and in rectified spirit; its aqueous solution has a neutral reaction. Heated in a test-tube it almost entirely volatilises, violet vapours of iodine being set free.

LIQUOR ARSENII ET HYDRARGYRI IODIDI—SOLUTION OF ARSENIOUS AND MERCURIC IODIDES—DONOVAN'S SOLUTION.

CHARACTERS AND TESTS.—A clear, pale yellow liquid with a metallic taste, sp. gr. 1.016.

SODII ARSENAS—SODIUM ARSENATE—DI-SODIUM HYDROGEN ARSENATE (Na_2HAsO_4).

The *liquor sodii arsenatis* contains $4\frac{1}{3}$ gr. of the anhydrous salt in 1 oz. of distilled water (1 per cent.).

CHARACTERS.—The salt occurs in colourless transparent prisms, soluble in water and alkaline in reaction; the solution is also colourless and alkaline.

Arsenic Acid (As_4O_6 and As_2O_3), the higher oxide of arsenic, is also white and solid, but is so soluble as to be almost deliquescent, and it has a strongly acid reaction. It is not employed in medicine in its free state, but in combination with soda and iron. In the arts it is largely used in the printing of cotton stuffs and in the manufacture of aniline dyes.

Ferri Arsenas—*Iron Arsenate* (v. Iron). *Cacodylates* (*organic arsenates*) (v. p. 533). *Liquor arsenii bromatus* (v. p. 518).

TESTS.—1. Sulphuretted hydrogen gives a bright yellow precipitate of arsenious sulphide (As_2S_3) in acid solutions of arsenious acid or the arsenites. With arseniates the same precipitate is obtained, but very gradually, as they must be reduced to arsenites previously.

2. *Hume's Test.*—Ammonio-nitrate of silver gives a lemon-yellow precipitate of arsenite of silver (Ag_3AsO_3) with a solution of arsenious acid or the arsenites, but with arsenic acid and the arsenates, a chocolate-coloured precipitate of arsenate of silver (Ag_3AsO_4).

3. Ammonio-sulphate of copper gives with compounds of arsenious acid a light-green precipitate of arsenite of copper (CuHAsO_3), Scheele's green; with arsenates, a somewhat similar precipitate of arsenate of copper. This test is not trustworthy as many harmless vegetable substances behave in the same way.

4. *Marsh's Test.*—Generate hydrogen by the action of sulphuric acid on zinc in a Marsh's apparatus, and add the solution supposed to contain arsenic; if arsenic be present it will combine with the nascent hydrogen to form arseniuretted hydrogen ($\text{As}_2\text{O}_3 + 6\text{H}_2 = 3\text{H}_2\text{O} + 2\text{AsH}_3$). On igniting the jet of gas (which burns with a bluish flame), and depressing upon it a cold porcelain plate, an arsenical stain will be deposited, whilst the hydrogen is burned off into water. The stain has the following characters: (a) metallic brilliancy; (b) hair-brown colour; (c) volatility; (d) solubility in solution of bleaching powder; (e) non-solubility in cold sulphide of ammonium; (f) when evaporated with a drop of nitro-hydrochloric acid it yields a residue of arsenic acid, which gives a brickdust-red turbidity on the addition of nitrate of silver. Fleitmann has shown that if the hydrogen be generated by heating zinc and caustic soda or potash together ($\text{Zn} + 2\text{NaHO} = \text{H}_2 + \text{Na}_2\text{ZnO}_2$) the hydrogen combines with arsenic but not with antimony; this reaction is valuable in the presence of both metals.

5. *Reinsch's Test.*—A piece of copper foil when boiled in an acid solution of an arsenical compound will become slate-grey from the deposition of a fine film of metallic arsenic. This test to be complete must be verified by heating the coated copper in a narrow glass tube, when a mixture of arsenious acid and metallic arsenic will sublime, and be deposited in octahedral crystals and

globules on the cooler part. For the "reduction test" of white arsenic, it should be placed with "black flux" in a similar tube perfectly dry, and on heating first the charcoal and then the arsenic, the latter sublimes and is deposited in a metallic ring as above mentioned.

ABSORPTION AND ELIMINATION.—Since the observations of Schmidt, Mialhe and others, *metallic* arsenic has been considered inert. Schroff however has shown that it may exert a strongly poisonous action, and that doses of 8 to 15 gr. have caused gangrene of the stomach and death in from thirty to forty hours (*Zeitschrift der Aerzte*, i., 1858). It is probably oxidised before absorption. Paschkis and Obermayer found that metallic arsenic in fine division in oil, or as an ointment, given hypodermically or rubbed into the skin, was absorbed. In every case arsenic was found in the fæces and urine, and during life symptoms of poisoning were manifested, while the *post-mortem* appearances were those of arsenical poisoning (*Wien. Med. Jahrb.*, 1888).

Arsenious acid in all its combinations, and by whatever channel introduced—by the mouth or by the rectum, by the lungs or by the skin—is readily absorbed, and has been detected in the blood a few minutes after its administration. It passes out by the skin and mucous membranes, by the various glands, as the salivary and even the lachrymal, but mainly by the kidneys.

Brouardel and Pouchet record that a man had tried to poison his wife by arsenic while she was suckling a child. The woman had vomiting and diarrhoea but recovered, while the two-months old child died with similar symptoms in forty-eight hours; its body was exhumed and 5 mgrm. of arsenic were found in 2 kilos. (The earth outside the coffin contained no arsenic.) They also gave nursing women from 2 to 12 min. of Fowler's solution per day, and found arsenic in the milk. In animals which got non-lethal doses of arsenic their suckling young often died, and arsenic was found in their corpses (*Annales d'Hygiène pub.*).

The rapidity of elimination varies; in some cases, none of the substance could be detected in the secretions three days after the last dose, but in Ludwig's observations on animals, if small quantities were given for a fortnight and then omitted the urine was not quite free till three weeks afterwards (*Med. Record*, 1877). Gubler gives six weeks as the time during which it may continue to pass out, and when it has ceased to do so it may reappear after

administration of iodide of potassium; hence it seems probable that elimination is not always complete, and that a part of what is taken may be deposited in the tissues and occasion so-called "cumulative" effects. It has been found to be specially deposited in the *nervous* system, and according to Professor Dixon Mann's researches, in the neurokeratin; thus, if in fresh muscle 1 part is found, the proportion in liver is 10·8, in brain 36·5, and in spinal cord 37·3 (Scolosuboff, *Annales d'Hygiène*, 1876). This became a matter of great importance in a French trial (Danval), when the experts were blamed for not examining the brain and cord (B. M. J., ii., 1878); these parts should henceforth be analysed as carefully as the abdominal viscera. Caillol (de Poncy) offers some analyses to show that arsenic partly displaces phosphorus in the chemical constituents of nervous tissue (*Med. Record*, 1878), and Roussin, that it does the same in bone (*Lancet*, ii., 1889). Dr. Putnam found traces of arsenic in the urine of 30 per cent. out of 150 specimens examined—the patients had obscure symptoms of illness not definitely arsenical—he supposes its absorption from many articles of domestic use (*Lancet*, ii., 1891). If any be contained in the body at death, it may be detected after an almost indefinite period.

PHYSIOLOGICAL ACTION.—*External.*—Preparations containing arsenic produce local irritation, inflammation or destruction of tissue, in varying degree, according to the strength and character of the application. Dry white arsenic in mass may not injure the unbroken skin, but arsenical powders are apt to produce eruptions of various kinds on exposed surfaces, and especially irritative effects on the pudenda, in those who are employed in the manufacture of green dresses, wall papers, artificial flowers, etc. (*Annales d'Hygiène*, B. M. J., ii., 1863). Perforation of the septum nasi has been noted, and anal ulceration has followed the local use of a green paper coloured with arsenite of copper. Arsenic dissolved or moistened is still more irritating, and those who use it, for instance in sheep-washing, generally suffer from eczema of the scrotum, etc. (*Lancet*, 1857). Workers with arsenical powders are liable also to various degrees of acute and chronic arsenical poisoning, and green colours are not the only dangerous ones: fuchsine, a *red* dye, contains much arsenic (*Med. Record*, 1877), and blue gloves have shown arsenic on analysis (B. M. J.,

ii., 1878). The use of green-coloured cards has caused a disease of the nails resembling psoriasis, and green hat-lining has caused eczema (Farquharson, B. M. J., ii., 1879). The external use of a "violet powder" adulterated with arsenic proved fatal to thirteen children out of twenty-nine subjected to it (B. M. J., ii., 1878).

The continued application of a strong arsenical compound has a caustic destructive effect, which is not simply a *chemical* one, like that of caustic acids or alkalies, and is not exerted on the dead subject, but is produced by interference with nutritive processes in the part, causing rather a condensation and "mummifying" of tissue than an actual destruction. It is much more active in unhealthy, ill-nourished tissue (*e.g.*, that of lupus), than in normal tissues. Very strong arsenical applications produce much local inflammation, and so far interfere with the action of the absorbents that the effect remains local only; but unless in such strong concentrated form, arsenic is readily absorbed, especially from wounds and mucous surfaces; hence its surgical use has led to serious constitutional symptoms, and even to death. Roux describes the application of an arsenical ointment—1 part in 32—over a space of $1\frac{1}{2}$ square inch of a cancerous breast for one night only, followed by death from poisoning on the second day. Sir Astley Cooper relates a fatal case from the use of an arsenical solution to a "fungus of the eye" (Lancet, i., 1837). Arsenical paste applied to an inflamed tooth-pulp has also proved fatal, and Graham has recorded vomiting, severe pain, convulsions, and death from the application of a plaster containing half its weight of arsenic to a cancerous breast (Glasgow Med. Journ., 1869); the prescriber of the plaster was tried for homicide, and many similar cases have been before the law courts.

The *antiseptic* power of arsenic deserves mention: it is largely utilised in the dissecting room, and seems to have retarded the process of *post-mortem* decay in some cases of poisoning when large amounts have been used (*cf.* Antimony). The researches of Johannisohn assign it, however, but a limited power: he found that small quantities checked fermentation in yeast and syrup, but only for a time: in lactic fermentation it diminished the growth of one fungus, but favoured another. The same thing occurred in urine: it exerted no influence on non-organised ferments, such as pepsin, etc. (Archiv. f. exper. Path., Bd. ii.).

PHYSIOLOGICAL ACTION.—*Internal.*—The blood and the metabolic processes are altered by arsenious acid and its compounds, but the symptoms of its physiological action are mainly evinced in the *alimentary canal*, the *skin* and *mucous membranes*, and the *nervous system*, and in different cases these parts are affected in different degree, according to the dose, the time and mode of its administration, and the constitution of the individual.

Digestive System.—Small doses— $\frac{1}{60}$ to $\frac{1}{15}$ gr.—may be taken for some time without other effects than such as are of stimulant and tonic character—*e.g.*, improvement of appetite, sense of warmth at the stomach, and general invigoration; but usually, sooner or later, these symptoms are replaced by those of irritation and malaise. Trousseau quotes from Koepl the case of a servant who, desiring to get rid of a severe mistress, mixed with her food for some time very small doses of arsenic: the mistress however improved in appearance and in stoutness, and the plot was only detected after the use of a large poisonous dose. Doses of $\frac{1}{15}$ to $\frac{1}{2}$ gr. are liable to produce soreness of the mouth, with some salivation and dysphagia, foetid or sour taste, thirst, heat and constriction in the pharynx, with nausea or vomiting, gastric pain, flatulence amounting to tympanites, and diarrhoea. Vaudrey found copious pultaceous stools follow the medicinal use of arsenic without toxic effects. One of the early symptoms of the physiological action of the drug is a slimy silvery aspect of the tongue, “as if nitrate of silver had been lightly applied” (Begbie), an appearance produced by a thin coating of mucus secreted under the influence of irritation. After continued doses, the tongue becomes red or brown, cracked and tremulous, the gums bleed, and the buccal mucous membrane may be covered with aphthous or even membranous patches like a true diphtherial condition (B. M. J., i., 1862). Vomiting becomes so frequent that all food is rejected, and emaciation sets in rapidly, an effect which has been termed “*tabes arsenicalis*”.

After poisonous doses, which may be stated at 2 gr. and upwards, the symptoms already described become intensified; pain, especially of severe burning, cramping, spasmodic character, comes on within half to one hour, in the region of the stomach and navel, spreading thence over the whole abdomen, which becomes contracted and hard: the ejecta are offensive and yellowish or greenish in colour, not unlike bile (unless, as often occurs in

cases of poisoning, arsenic mixed with soot or indigo has been used); hiccough attends the vomiting and purging; the latter becomes involuntary and is accompanied with severe tenesmus, and the general symptoms may closely simulate those of cholera (Lancet, ii., 1870).

On the other hand in some exceptional cases, the vomiting has been only moderate, and there has been complaint of coldness rather than heat (*cf.* Maybrick's case, B. M. J., ii., 1889). In others, there has been almost entire absence of pain, the patient remaining in a dull and semi-narcotised condition, and in several even severe cases, a remission of symptoms has occurred for some days before death (Guy's Reports, 1850).

In experimenting with frogs, Dr. A. Lesser found that intestinal peristalsis was increased by arsenic, and local tetanic contractions occurred from direct irritation of ganglia in the intestinal coat (not indirectly from influence of the central nervous system): gastro-enteritis was also produced by the drug, but he did not, as Böhm did, find it more poisonous when given by the mouth than by a vein. It was eliminated by the intestinal mucous membrane (Virchow's Archiv, 1878; Lancet, ii.), and we may add here that by whatever channel toxic doses of the drug are given to men or animals, gastric inflammation is commonly produced. Arsenic diminishes the amount of glycogen in the liver, and if it is given for a length of time, glycosuria does not ensue on puncture of the floor of the fourth ventricle.

Nervous System.—The early effects of very small doses are usually tonic in character, there being a general sense of improved power. The same fact was noted when describing effects on the digestive system, and it is possibly not a primary tonic effect upon the nervous system itself, but rather dependent on improvement in appetite and assimilation of food. In several neurotic subjects, very sensitive to medicines, I have noticed a general condition of nervous irritability and especially of sleeplessness amongst the earliest effects of even moderate doses of arsenic.

Full medicinal doses, continued for a long time, give rise to numbness and pricking sensations with tremor or stiffness of the limbs. Sometimes *headache* has been a marked symptom, as for instance in a large number of children who each received about 1 gr. of white arsenic in milk (Taylor), and in many persons

poisoned by the accidental admixture of a small quantity of arsenic in bread: they suffered also from a feeling of constriction over the forehead, vertigo, and tinnitus (Lancet, i., 1880), from visual sensations of light or flame, prostration and feebleness of the lower extremities, and in these as well as in other cases pain in the back has been a marked symptom (B. M. J., i., 1873); sometimes the extremities have been very sensitive (neuritis). Restlessness, insomnia, grinding of the teeth, giddiness, irritability and depression are frequent symptoms.

The effects of *poisonous* doses (6 to 8 gr.) are often ushered in with rigors, profound depression, and extreme anxiety. Restless tossing of the arms is commonly noted, and later, numbness, cramps and twitchings of all the muscles. The œsophageal spasms may simulate those of hydrophobia, and the muscular cramps may amount to opisthotonos—convulsions alternating with delirium, the special senses become impaired or lost, the mental faculties torpid (the stupor may suggest narcotic poisoning), and syncope or collapse may close the scene. There may be local palsies, as of the limbs and sphincters in the course of arsenical poisoning, also of sensory and motor and *probably* of vaso-motor nerves. Dr. Sklarek, experimenting on the frog, found that arsenical injections, in minute quantities, destroyed common sensibility, probably by their influence on the cord (Reichert's Archiv, 1866). Lesser, whilst verifying this, noted a transient increase in reflex irritability, then diminution of it, then cessation; after some time the frog became completely paralysed.

Drs. Ringer and Murrell, remarking that paralysis occurs in the same order after *mechanical arrest of circulation* (as by ligation or excision of the heart), instituted experiments to show whether the latter was the real factor in Sklarek's results, and concluded that they were due rather to a toxic action on the central nervous system; peripheral motor nerves retained their function for some time, for the muscles continued to contract under direct galvanic stimulation; ultimately both nerves and muscles were paralysed by arsenic, and ceased to react long before similar muscles did in a *brainless* frog, and the observers named conclude that "arsenious acid is a protoplasmic poison, affecting first the more highly organised nervous centres, next the nerves, and last the muscles: . . . that it is a poison to all nitrogenous

tissues" (*Journal of Physiology*, 1878-79). Arsenic produces paralysis mainly by causing an inflammation of the peripheral nerves, but it also produces changes, whether primary or secondary to those of the nerves, in the anterior horn cells of the spinal cord. A very severe case of arsenical neuritis following one toxic dose is recorded by Dr. H. C. Wood (*Pract.*, 1889).

Christison has remarked that arsenical palsy resembles that of lead, but it is not less like the palsy produced by alcohol, inasmuch as it attacks the extensors of the ankles as soon as those of the wrists, and the sensory symptoms are as acute in arsenical as in alcoholic paralysis.

Dr. Mills found marked myelitis in a case of arsenical poisoning (*Med. News*, 1885). Popow found that in dogs arsenic produced a central and then a diffused myelitis (*Virch. Archiv*, Bd. xciii.). M. Vrigens considers that the fundamental character of arsenical poisoning is a perversion of the entire nervous system, the vagus, sympathetic and vaso-motor nerves being specially affected (*Archives de Physiol.*, viii., 1881). Krehl also records a case of arsenical paralysis. The patient in four months had taken 1.346 gramme arsenious acid (about 20 gr.); sensation in the hands, muscles and tendons was disturbed, and the muscles degenerated and wasted, but they did not show the reaction of degeneration (*Deut. Archiv f. klin. Med.*, xlv.).

Falkenheim has reported three cases of atrophy of muscles (after acute arsenical poisoning) with diminished electric irritability, and well-marked reaction of degeneration, the extensor muscles being more affected than the flexors, and peripheral neuritis being the probable cause (*Cbl. f. d. med. Wiss.*, 1888). An interesting case of multiple peripheral neuritis obscure in origin and development was at length traced to chronic arsenical poisoning, induced by continuous working for several months with muslin which the patient tore up for curtains, cushions, etc., and which was found to be impregnated with arsenic (*Lancet*, i., 1889). Two examples recorded by Dr. S. Barton equally illustrate the obscurity of origin: a wife first was admitted to hospital with peripheral neuritis, which had commenced after severe headache and diarrhoea; there was also pigmentation of the skin, but the case was not cleared up until later, when the husband was admitted

with similar symptoms, and was found to be a "naturalist," accustomed to rub arsenical powder into his specimens as preservative. Arsenic was readily detected in the urine when tested for (Lancet, ii., 1890). The neuritis commenced, in one case, seven days after a dose of $2\frac{1}{2}$ gr., and in others, three and four weeks after *acute* toxic symptoms (Pract., 1890). One man, a shoemaker, was affected after handling green labels (*ib.*, 1891, v. epidemic peripheral neuritis, p. 491).

Circulatory System.—After administration of arsenic, analysis has detected it in the blood clot—*i.e.*, united with the corpuscles and not simply dissolved in the plasma. Claude Bernard taught that it acted on the corpuscles in such a manner as to diminish the activity of interchange of oxygen and carbonic acid (Med. Times, ii., 1861). The experiments of Brodie had already indicated *undue fluidity* of blood as an effect of arsenic, and modern observations refer this condition to a solvent action on hæmoglobin: thus, if arseniuretted hydrogen be passed into defibrinated blood it becomes black, and gives with the spectroscope one large dark band instead of the two normal ones; by degrees, the spectrum wholly disappears, the hæmoglobin is destroyed, and the liquid turns yellowish-green. It seems probable that the same gas is developed to some extent from arsenates absorbed into the living organism, and that it exerts a similar destructive action on the corpuscles; this would explain the anæmia, and the consequent œdema and anasarca met with after continued use of even medicinal doses, as well as the icteric tint of the skin, and the petechiæ and hæmorrhages in cases of poisoning. Though there is evidence that in certain forms of anæmia the number of the corpuscles is increased under arsenic (Gowers, Pract., July, 1878, and Bramwell), there can be no doubt that an opposite result follows both its long-continued use in disease, and any appreciable quantity of it taken by healthy persons. Cutler and Bradford found that in health the red and white corpuscles were diminished in number under arsenical medication, and Mr. Malcolm Morris reports diminution in some cases of psoriasis when the general health was good—*e.g.*, F., aged twenty-three, on August 14th, showed 53 corpuscles in each square (of Gowers' instrument), was ordered Fowler's solution (*m v ter die*), and on 21st showed 48 only per square; continuing treatment, on September 11th there were only 37·3—

the eruption was nearly gone (Pract., 1880). But in the ordinary condition of anæmia both the red and white blood corpuscles are increased in number by moderate doses of arsenic. Stockman and Greig have investigated the action of arsenic on the blood and bone marrow in rabbits and dogs (Journ. of Physiol., 1898), and found that although there is no direct increase in the number of the red or white blood corpuscles or in the amount of hæmoglobin, yet the red bone marrow—one of the principal seats of the formation of red blood corpuscles—was markedly stimulated. The number of white corpuscles remained the same. Of other recent observers, Aposti states that in animals rendered anæmic by bleeding, etc., small doses stimulate corpuscle-formation (Centralb., Leipzig, 1900), and Bettmann affirmed the same of healthy animals (Beitr. z. Path., etc., Jena, 1898), but Stockman has shown their conclusions to be unwarranted. Besredka found that under full doses the polynuclear leucocytes were increased and that with toxic doses they were reduced (Ann. Instit. Pasteur, Paris, 1899).

The force and frequency of the heart's action and the activity of the capillary circulation are usually increased by minute doses (Feltz, Harless), and especially in weakly persons; larger quantities induce palpitation with quick, small, and irregular pulse; the face is flushed, while the extremities are cold.

Poisonous doses markedly depress the circulation, and ultimately arrest the heart (in diastole) in the lower animals, and as found by Sklarek in batrachia and in cats, there is no previous stage of excitement (Reichert's Archiv, 1866). Although the frog lives on for ten minutes after arrest of cardiac action, no stimulus will re-excite this, and yet irritability of cardiac *muscular* tissue persists, so that Sklarek concluded that arsenic paralysed the motor ganglia of the heart. Unterberger also records a very pronounced fall in the blood-pressure and pulse-rate (Archiv für exper. Pathol., Bd. ii.). There is clearly a direct depressant effect on the heart—in fact this causes death in cold-blooded, though not usually in warm-blooded animals. Some palsy of the vaso-motor nerves is also indicated, and according to several experiments this is limited to the abdominal division of those nerves. Though Lesser verified Sklarek's observations he did not come to the same conclusion that arsenic causes death by

paralysis of the heart, but denies it for the simple reason that frogs survive excision of the heart for more than thirty minutes, whilst arsenic kills them in ten minutes. Drs. Ringer and Murrell found (in frogs) a *varying* effect upon the heart, it being sometimes completely arrested, sometimes continuing to beat after complete general paralysis, but they explain the difference by a variation in dose; a large one being quickly absorbed and conveyed to the heart arrests it at once, leaving little for the circulation to distribute, whilst a small dose paralyses the central nervous system before the heart (*loc. cit.*). In warm-blooded animals the pulse-rate was increased at first by small and medium doses injected into the veins, afterwards it was diminished; by a large dose it was decreased at once, and the blood-pressure reduced. The increase of the pulse-rate was traced to lessened influence of the vagus and increased action of cardiac ganglia, the decrease of pulse-rate to contrary conditions. Stimulation of vaso-motor centres was not marked unless injections were made directly into the carotid, and Lesser could not verify paralysis of those centres under any conditions (Virchow's Archiv, 1878). In the human subject, the pulse usually becomes weak, rapid and gradually more irregular till the heart's action ceases: venous stasis naturally occurs, and there is pallor, lividity and finally cyanosis of the surface and of the visible mucous membranes.

Respiratory System.—Lesser verified a markedly stimulant effect of small doses, both on the respiratory centre and on the pulmonary terminations of the vagi; large quantities, on the other hand, extinguished irritability in these parts. That the effect is directly on the *centre* is clear from its occurrence even after section of the trunks of the vagi, but when these nerves are entire the effect is greater, so that they have some share in it. Small doses taken under certain conditions—as, for instance, by the Styrian mountaineers—are said to render the respiration easier, less laboured and less hurried under severe exertion. On the other hand, even medicinal doses, if long continued, will induce in some persons a dyspnœa, allied to that of emphysema or even asthma, with dry cough or hawking of mucus. This I have verified several times in the subjects of eczema, observing its cessation with the omission of the drug, and its return under arsenical influence;

there may be also hoarseness, coryza, tonsillitis or even, according to some observers, bronchitis (McCall-Anderson), probably from irritation excited in the bronchial mucous membrane by the elimination of the drug; it has certainly some special determination to the pulmonary tract. After large poisonous doses the dyspnœa is often urgent, and the respiration stertorous.

Cutaneous System.—In frogs, one effect of arsenic is to cause a ready peeling or stripping of the whole cuticle some hours after hypodermic injection (Ringer and Murrell); this has been shown by Miss Nunn to be due to the degeneration of the lowest layer of the epidermal cells (Journ. of Physiology, v., 1). Other epithelial structures are also affected, and Cornil has found fatty degeneration of the epithelium lining the air-cells in the lungs of animals poisoned by arsenic. In man small doses, continued for a limited time, improve the condition of the skin, and often (but not always) impart freshness and ruddiness to the complexion, whilst in animals they render the hairy coat more glossy and bright. Köhler remarks that since arsenic is eliminated by the sweat-glands (especially when they are acting vicariously for the kidneys), there is nothing remarkable in its modifying the circulation and nutrition of the skin, and its effects are explained by a capillary congestion and the presence of more blood in the superficial vessels, and this again has been attributed to a vaso-motor palsy allowing dilatation of such vessels.

Rabuteau thinks such a view cannot be accepted, because the temperature is not raised as it is in experimental vaso-motor palsy—*i.e.*, after section of the sympathetic. This I think is a question of degree—the rise might be more or less according to the amount of paralysis induced by a drug—it would not be so complete as after section. Moreover, Harless reports a distinct rise, though recent experiments indicate a fall of temperature as the more *usual* condition connected with arsenical action (Lolliot).

When the drug is omitted after continuous use, an opposite condition—one of pallor and anæmia—is said to follow (Med. Times, ii., 1854). Certainly arsenic, if long continued, leads to an unhealthy, dry, and somewhat scaly condition of the skin, which has been called by some *pityriasis*, and by others even *psoriasis*,

though I have never seen anything like a true case of the latter malady thus caused.

Perhaps the extreme and most characteristic cutaneous result of arsenical saturation is a brown colouration of the face and various parts of the body, which has sometimes been seen in such a form as to resemble argyria, *e.g.*, a lady had taken for fifteen months comparatively large doses of arsenic for gutta rosacea, and two months after commencing the medicine a change of colour was noticed in the skin, first over the abdomen, then on the breast, neck, face and hands. When seen by Prof. Wilson the face was yellowish-brown, the eyeball dark, the whole body coloured more or less; chronic erythema affected the palms, there were hard dry points at the sweat-glands, the eyelids and the extremities were oedematous (*Journ. Cutan. Med.*, vol. i.). In some of Mr. Hogg's cases, children got a "dusky skin eruption in patches" from arsenical wall papers (*B. M. J.*, i., 1879). Some bronzing in a child suffering from chorea has been recorded from 5 min. of liquor arsenicalis, given thrice daily for about one month—it affected only the covered parts of the body and ceased on the omission of the drug (*B. M. J.*, i., 1886). Such a condition depends not on chemical combination (as with silver), but on abnormal pigmentation (Gubler), and in recent years it has been well recognised.

Cold clammy perspirations have also been connected with arsenical action, and pustules and ulcerations have sometimes followed it. In acute cases, either of poisoning or of unusual susceptibility to the action of the drug, patches of erythema or of urticaria (local congestions of skin) and even acute general lichen may occur. Macnab recorded an eruption like measles produced by 3 min. doses of Fowler's solution daily for three weeks (*Med. Times*, i., 1868), and Wyss says that he traced to it a case of alopecia areata—from affection of the trophic nerves of hair-follicles (*Archiv der Heilk.*, 1870).

Amongst rarer consequences, erysipelas with bullæ has been credited to arsenic, also herpes zoster, psoriasis, etc., by Mr. Hutchinson (*Archives of Surgery*, 1, 2), and an obstinate eczema by Dr. Balfour (*Edin. Med. Journ.*, 1860); herpes labialis sometimes occurs during its administration. Dr. Imbert Goubeyre has specially written on arsenical eruptions, and in

cases of acute poisoning when the patient survived several days, has seen them petechial, papular, vesicular, and pustular.

A degree of cutaneous swelling, characteristic enough to have received the name "*œdema arsenicalis*," usually occurs first about the eyelids and suborbital tissues, and is one of the early symptoms of constitutional action. J. Feitelberg (Inaug. Diss. Dorpat, 1883) showed that a number of poisons increase the acidity of the blood by diminishing oxidation, the sarcolactic and carbonic acids being especially increased; arsenic acts markedly in this way, and as weak acids cause dilatation of vessels (Gaskell) the arsenical œdema is so explained by Sir Lauder Brunton (Pract., ii., 1883). In severe cases it may affect the extremities and even the trunk, and amount to general anasarca, as recorded so early as 1819 (Edin. Med. Journ.). In Dr. Feltz's cases already referred to, there occurred on the second or third day swelling of the eyelids and conjunctivæ—in some instances of the whole face, with a rash like scarlatina or urticaria. In most of them there was itching of the surface, and scratching gave rise to an urticarial rash; in one man the same eruption, together with herpes, appeared on the scrotum.

Mucous Membranes.—We have already noted characteristic arsenical effects upon the mucous membrane of the mouth and intestinal canal. The lips, the nose especially at its orifice, the anus, and the vulva often become similarly irritated and inflamed, and urethritis has been traced to medicinal doses of arsenic (Med. Record, 1878). On the mucous membrane of the *eye* the effect of the drug is often very early seen, so that it becomes a useful index of the degree of physiological action. Itching about the lids is first complained of, and a rough sensation as of dust in the eye; the conjunctiva is seen to be congested, and purulent secretion may be formed. Conjunctivitis is a frequent symptom in arsenical poisoning, and Dr. Taylor describes "tumid, everted lids and painful vision" in patients affected by arsenical papers, etc. (Ophth. Hosp. Rep., 1859, and B. M. J., ii., 1871).

Chronic naso-pharyngeal catarrh, like a continued "cold," has been traced to the use of an arsenical hair-wash: for a long time this was not suspected, and various remedies and changes of climate were tried without good result, until the wash was stopped (Dr. D. Hood, Lancet, i., 1890).

Glandular System.—Under small doses of arsenic the secretions are increased, especially of those glands by which the drug is eliminated. Increase of the quantity of the saliva is exceptional in acute poisoning, but occurs when absorption takes place slowly and gradually. The bile, the intestinal secretions and generally speaking the urine, are augmented under its use (see urinary system); and if there be no diuresis the perspiration is commonly stimulated, and arsenic can be detected in it (Köhler, Handbuch). In six cases of poisoning from arsenic in the paper, etc., of rooms, jaundice was one of the symptoms (B. M. J., ii., 1889). Hoffmann, Glauber, Agricola and Pott have even recommended arsenic for a diaphoretic effect, and I have myself sometimes observed this from it.

Osseous System.—Struck by Wegner's observations on the changes in bone produced by phosphorus, and following up the paper of Maas, "On the Influence of Arsenic in Bone-growth, and Its Value in Surgical Therapeutics" (1872), Th. Gies has published some careful and interesting experiments which well illustrate such influence (Archiv f. exper. Path., Bd. viii.). Using at first young rabbits badly nourished, he found that arsenic destroyed them *without* causing any changes in the bones; but having, by careful food, secured for fresh animals apparently more resisting power, the same daily doses (0.005 to 0.002 gramme arsenious acid) continued for nineteen to thirty-four days seemed to improve their condition, as compared with rabbits from the same litter, and fed in the same manner (but without arsenic): the former were larger, heavier, with clearer skin, and healthier-looking than the latter, and after death the respective bones could be at once distinguished. In the long bones of the arsenic-eaters was a special thick layer (Arsenschichte) of bone between the epiphysis and the shaft; the shaft also was thicker, and in bones such as the ribs and the vertebræ, the structure was much more dense, and harder to divide than in normal animals; the new structure was true bone, but the bone-corpuscles and Haversian canals were smaller than the average. Comparative experiments were made with many rabbits, cocks and pigs, and in such manner as to leave no doubt whatever that increased growth and condensation of bony tissue were traceable to the action of arsenic. In old animals where epiphyseal growth had ceased, increase of thickness of the bones was found: on the other hand, if

the doses were raised beyond a certain point, reabsorption of bone occurred and symptoms of poisoning set in. Bones purposely fractured had not united under the treatment, for their small size made it impossible to keep them in position, but a false joint formed, and much callus was round the broken ends; there was fatty degeneration of all internal organs. Gies does not adopt Wegner's view of increased stimulus given to bone-formation, but rather that of Cunze and Lolliot, that arsenic diminishes tissue-change especially as regards carbo-hydrates, and hence follow increased deposit and insufficient removal of organic particles.

Genital System.—This often shares in the general stimulation and irritation induced by small doses of arsenic, as has been noticed in the arsenic eaters of Styria, and in experiments on animals. Gies especially remarked it in the cocks used for his observations on bone-growth (*loc. cit.*). Clinically, Prof. Charcot was led in two cases to a contrary conclusion, but Devergie showed that this could not be sustained, and that stimulation to some extent was not unusual (*Bull. de Thérap.*, 1864); this, however, is not such as to preclude the medicinal use of the drug, and it finds its place in the treatment of amenorrhœa.

In *arsenical poisoning*, inflammation of the genitals has been said to occur (Hunt), and certainly much irritation of them has been present, especially in women; but it would seem to be connected rather with the general irritation of mucous membranes than with these special organs. The young of animals subjected to an arsenical course were born dead, but fully developed; their birth was delayed rather than premature (Th. Gies), and no markedly injurious effect could be traced on the uterus. In many instances of arsenic being taken by pregnant women, even when with fatal results, abortion has not occurred (Guy's Reports, vol. vii.).

Urinary System.—The urine is commonly increased in quantity for a time under small doses, but with their continuance renal irritation may be induced, so that the secretion is lessened and elimination of the drug impeded. Hence it is an important practical point to examine the urinary condition during arsenical treatment, and to use if necessary alkaline diuretics. Lolliot traced hæmaturia and albuminuria to arsenic, and in a case of phthisis, carefully recorded by Dr. Weir Mitchell, albuminous

urine was induced by 4 to 12 min. of Fowler's solution given daily for a few weeks; anasarca also set in, and these conditions ceased and then recurred concurrently with omitting and resuming the medicine (New York Med. Journ., vol. i.). After poisonous doses the urine, though at first it may be passed too often, soon becomes scanty, and its evacuation causes scalding pain and tenesmus; it may contain blood, albumin and casts, and sooner or later becomes suppressed; urethritis has been already mentioned.

Urinary Excretion in Relation to Tissue-change.—The estimation of urea and other constituents of the urine furnishes important evidence as to the influence of arsenic upon general nutrition and tissue-change, for it is clear that if the principal urinary ingredients are increased under its use, tissue-changes must be going on rapidly, and *vice versa*. There has been some contradiction between observers on these points. Sabelin recorded *increased* excretion of urea under arsenic (from 12 to 28 gr.)—Hubbard corroborated it (Record, 1882); also marked increase in the chlorides and earthy phosphates, and proportionate diminution of uric acid,—an incompletely oxidised product, hence G. Sée argued that the drug favoured oxidation and promoted metabolism (Nouv. Dict., Art. Asthme)—he has, however, himself since withdrawn these views. Fokker published two analyses showing a slight increase of urea after 0.01 gramme doses (Schmidt's Jahrb., Bd. clviii.), and Gaehtgens recorded the same in two dogs taking sodium arseniate; also decidedly increased tissue-change under toxic doses (Centralblatt f. Med., 1875 and 1876). Binz and Schulz relying upon these observations, and noting also that hypodermic injection of arsenious acid did not produce a local caustic effect but inflammation in distant organs—*e.g.*, the stomach—have argued that “this substance, in contact with living protoplasm, acts in the tissues as an oxidising agent or carrier from one albuminous molecule to another, being converted during this process into arsenic acid, then reduced, again oxidised, and again reduced” (Centralblatt f. Med., ii., 1879; Med. Times; i., 1879). But I think the evidence insufficient for the conclusion, and all observations upon fasting animals are open to the fallacy that *urea may be increased by the fasting*, and consequent destructive metabolism of proteids in the tissues. The dogs utilised by Gaehtgens were kept many days on water only,

and a careful examination of the whole question leads to the conclusion that the "tissue-change of inanition" is almost surely the explanation of what he attributed to arsenic (F. A. Falck, *Archiv f. exper. Path.*, 1877, Bd. vii.). Von Böck attributed any change he could observe to the effect of fasting, and held that arsenic acid *in ordinary doses* exerted no essential influence on tissue-change (*Zeitschr. für Biologie*, vii.).

Others have concluded positively that it *lessens* excretion and tissue change. Thus Lolliot in a careful thesis records many observations and analyses, from which he makes evident a *diminution* of urea and carbonic acid under arsenic; he asserts, also, that it lowers temperature, and is a "médicament d'épargne"—it lessens the activity both of nutrition and denutrition (*Etude Physiol. de l'Arsenic*, Paris, 1868). Köhler classes it with tea, coffee and cocoa, as "Sparmittel"—diminishing oxidation processes (*Handbuch der Physiol. Therap.*, 1876). In experiments by Dr. Tamassia (Pavia), toxic doses of white arsenic given to animals, progressively lowered temperature up to and after death (*Med. Record*, 1878). Animals accustomed to an arsenical ration became pyrexial and emaciated on its withdrawal, implying that some moderating power had been removed. There is still, however, a discrepancy in the observations on temperature; Harless reported a slight rise from small doses, and Billroth, gradually increasing the dose to 40 min. daily in a case of asthma, reported a febrile access in the evenings up to 101° F. (*Wiener Woch.*, 1871).

Schmidt and Brettschneider found the excretion of urea and carbonic acid diminished 20 to 40 per cent. under arsenic; phosphates also diminished. Schmidt and Stürzwage likewise report diminution of carbonic acid and urea in rabbits under minute doses (Schmidt's *Jahrb.*, Bd. clviii.), and Rabuteau states that the elimination of urea in a dog was lessened for three weeks after a few doses of arsenious acid—at one time as much as 60 per cent.; he attributes its effect in lessening tissue-change to an action on the blood-corpuscles.

I conclude that although some contradiction exists on this point between good authorities, yet the balance of evidence points to *lessened excretion*, and consequently to *lessened tissue-change* as a physiological effect of arsenic. This is not incompatible with

small doses improving for a time nutritive activity by stimulating the stomach to appetite and digestion.

Acute and Chronic Poisoning.—Although not here concerned with cases of poisoning further than as they illustrate physiological action, we may note that if death occurs from large doses of several drachms and in the course of a few hours, it is generally from *cardiac palsy*, and is preceded by excessive prostration and fainting. If 1 or 2 dr. have been taken, and the patient survives two or three days, the symptoms will be mainly those of *severe gastric and intestinal inflammation*, as already described, and the *post-mortem* appearances will correspond; whilst with doses of 2 to 10 gr., when the patient survives much longer, and yet dies ultimately from the effects, these will be evidenced rather in the *nervous system* (Hunt). If the poisoning be very chronic, and result from continued doses of $\frac{1}{8}$ to $\frac{1}{4}$ gr., a general irritation of the system is apparent from the symptoms of *erethism* or *pyrexia* with *chills*, redness of eyes and of the orifices of the nose and anus, *keratosis* on the palms and soles, with dryness of the skin and pigmentation, pain in the head, joints and abdomen, with vomiting, purging and gradual *marasmus*. The soreness of the mouth and salivation have sometimes suggested *mercury* as the poisonous agent, and sometimes the general condition has been mistaken for *phthisis*, or for *typhoid*. Gaehtgens further suggested points of resemblance with *diabetes* and with *phosphorus poisoning* (Cbl. f. Med., 1875, Bd. xiii.). An instructive case which, for a time, deceived the medical attendants, and yet which reveals exactly the physiological action of arsenic as we have described it—including renal and nervous symptoms—is that of Mrs. Wooller as related by Sir R. Christison (Edin. Med. Journ., 1855). Dr. F. A. Macpherson has recorded a case of chronic arsenical poisoning produced by the administration of Fowler's solution in *psoriasis*, in which several exceptional symptoms occurred, of which the most striking were a husky voice, throbbing in the head and ears, and a tingling of the skin; the power of mental concentration was dulled, and sexual power diminished.

Epidemic Peripheral Neuritis.—During the latter months of 1900 a large number of cases occurred in the Manchester district, also in Liverpool, Chester and the Midlands, which were

thought at first to be alcoholic neuritis until Dr. E. S. Reynolds recognised that certain symptoms, besides the paralysis, were more marked than they would be in that disorder, *e.g.*, early and extreme cutaneous and muscular tenderness, numbness and tingling, herpetic and erythematous rashes, keratoses, bronzing of the skin and coryza; sometimes, but not invariably, diarrhœa and vomiting.

The aspect of many patients was typical—the face being puffy, especially about the eyes, which were suffused, and the skin dark from pigmentation; this sometimes extended over the whole body, but in other cases was in patches, always more marked at sites of pressure, or in the armpits, nipples or near the genitals, as in Addison's disease. The erythematous rashes varied, resembling eczema, measles, or sometimes scarlatina, and were irritable and with scaly desquamation, blisters, or warty growths; and keratoses occurred on the hands and feet, which also often showed signs of "erythromelalgia," with sweating.

The signs of affection of the *nervous system* included some mental confusion and loss of memory, but not so much as in ordinary alcoholism; the paralyses were similar, except that the sensory and vaso-motor symptoms were more marked. In some, the hand-grasp and the power of the anterior tibial muscles were merely weakened; in others, there were wrist-drop and foot-drop with "high-stepping" gait—in the most marked the arms and legs were entirely paralysed and atrophied, and finally the trunk muscles and diaphragm, so that several died (most of them women). In most of the cases with motor weakness, there was great tenderness of the muscles on deep pressure.

As to the *circulation*, there was more or less failure of the heart-muscle with œdema of the feet and legs,—pulse of low tension, rarely a mitral bruit. Temperature was often raised. The tongue was often coated with a silvery "fur," and stomatitis, gastric catarrh and vomiting were usual. Dr. Reynolds and others contrasted the symptoms of alcoholism and beri-beri, but so soon as he found arsenic in the beer, and others found it in the secretions, the real causation was cleared up (B. M. J., Nov., 1900). The actual amount in different beers varied, according to Mr. Kirkby, from 0.01 gr. to 0.28 gr. per gallon in terms of arsenious acid; and it has been estimated that 1 gr. in 3 gallons would be a dangerous amount (*ib.*, Dec., 1900).

It was shortly ascertained that the toxic agent was in the commercial sulphuric acid used in making *glucose* (by acting on starch) and also in making "invert sugar" (by acting on cane sugar). Dr. H. Dixon found this acid to be highly contaminated, and Drs. Delépine and Tattersall estimated the amount by weight of arsenious acid to be 1.4 per cent.; it was derived no doubt from the iron pyrites, in the roasting of which sulphur and arsenic pass over together into the condensing chambers, to appear later as "commercial acid". Dr. N. Raw and others found arsenic in the urine of many of the patients, and Dr. Dixon Mann crystals of it in the epithelium from desquamating cases, as well as in the thickened nails and hair (B. M. J., ii., 1900; i., 1901). It is remarkable what comparatively small doses sufficed to cause symptoms. One man who had been a teetotaler for six months took to drink and consumed 36 pints of beer in three days, and in forty-eight hours showed early symptoms of neuritis.

Taking Mr. Kirkby's average of $\frac{1}{10}$ gr. of arsenic per gallon, this would be equivalent to nearly $\frac{1}{2}$ gr.

Of course some patients are affected by medicinal doses amounting to less, say $\frac{1}{6}$ gr., but owing to idiosyncrasy—not as a rule—and there is much evidence that arsenic and alcohol combined have more influence in causing neuritis than either alone, as shown, *e.g.*, when Fowler's solution and brandy have been given for chorea. No doubt the drug has an irritant action on the kidneys, and thus possibly checks its own excretion and that of the alcohol also. The close resemblance of the paralysis produced by both made early diagnosis difficult; and Dr. Cran—who was one of the first to notice the epidemic—states that the earlier cases were much less typical than the later. Other explanations of the pronounced effects of small doses were found in some of the subjects having tonsillitis and others influenza, suggesting that the virulence of toxins was thus re-inforced. Dr. Tunnicliffe thought selenium might be to blame (B. M. J., Feb., 1901), but evidence before the recent Royal Commission seems to disprove this.

In a later paper (Dec., 1901) Dr. Reynolds notes that the pigmentation was absent or little marked in fair-complexioned people; that herpes zoster was moderately common, that neuralgia or anæsthesia affected various spinal and cranial nerves, that post-sternal and epigastric pain with breathlessness were often present,

and sometimes cardiac asthenia leading to syncope: bronchitis and dilated heart occurred, and the voice was often hoarse from catarrh and swelling of the vocal cords. Dr. Barendt has specially described the skin lesions (B. M. J., i., 1901), and Delépine the best process for analysis (*ib.*).

A Royal Commission on the subject sat in London from February to June, and took evidence in Manchester in March, 1901, and the epidemic subsided on giving up the use of the poisonous materials in brewing.

PATHOLOGICAL CHANGES.—In cases of acute poisoning the principal changes occur in the stomach and intestinal tract; redness and inflammation of these parts may be found within a few hours of administration; ulceration is not uncommon, gangrene and perforation are rare. In exceptional cases no marked redness has appeared, though arsenic has been found in the stomach (Taylor). Under full arsenical influence there is marked tendency to fatty degeneration of all tissues; in acute cases this is preceded by inflammatory change, and according to Dr. Pinkham it may be induced within forty-four hours (Med. Times, ii., 1878). Jaundice occurs, and after death the liver-cells, the renal tubules and the intestinal glands are found choked with granules and fat-globules, their epithelium being detached or destroyed. Salkowski found these changes in poisoned animals within three to six days, the glycogenic function of the liver being impaired very early (Virchow's Archiv, Bd. xxxiv.); it is noteworthy that, as already stated, in such cases the fourth ventricle may be punctured without causing glycosuria. MM. Cornil and Brandt find that the fatty degeneration produced by arsenic is less intense than that caused by phosphorus, and, moreover, that in the liver it is uniformly distributed throughout the lobules. It has been said that arsenical poisoning may be certainly diagnosed if besides gastritis there are found fatty heart, kidney and liver, with fluid dark blood and sub-endocardial ecchymoses (Lancet, ii., 1889). Virchow described a swollen state of Peyer's patches and the solitary glands, with fatty degeneration of epithelium and "rice-water" secretion containing a fungus that had been previously found only in cholera evacuations (Archiv, Bd. i., 1870). The mesenteric glands are also often enlarged (Lancet, i., 1884). A yellow pigment has been found lining the stomach and intestines in

bodies which have been exhumed after arsenical poisoning, and Dr. Stevenson has recorded several cases in which it was clearly shown that this is the yellow sulphide of arsenic (*Lancet*, i., 1884). In one case this was deposited on the endocardium (*ib.*, ii., 1892); in another case, however, a pigment very similar in appearance contained no arsenic and consisted simply of bile (*B. M. J.*, i., 1884). C. Gies has recently given additional evidence of fatty degeneration of tissue under continued small doses of arsenic, but notes also that the subcutaneous fat was increased, and the animals gained weight. Increase of fat and of weight have been observed in chronic arsenical poisoning in man (*Boston Journ.*, 1876).

In cases of poisoning, several attempts have been made to determine accurately the organs in which the metal accumulates. Thus, M. Garnier states that the liver is the place where it collects to the greatest extent. It forms no compound with albumin as some other metals do, and so he considers it possible that it forms insoluble arsenites and arsenates with the calcium salts of the fluids of the body (*Ann. d'Hygiène*, ix.). Professor Chittenden attempted to determine at what time before death the arsenic had been taken (*Amer. Chem. Journ.*, 1883). In one case nearly three times as much arsenic was obtained from the mouth and throat as from the kidney, and so it was thought probable that a large dose of arsenic had been taken just before death; the absence of arsenic in the brain, an organ distant from the seat of absorption, confirmed this opinion. (In cases of *chronic* poisoning the kidney contains a good deal.) In bodies which have been exhumed, it is always necessary to analyse the soil also, for, as MM. Schlagdenhauffen and Garnier have shown in the Vosges country, arsenate of iron may exist in large amount in the earth (*L'Union Méd.*, 1885).

TOLERANCE.—Arsenic Eating.—Under certain conditions the system may be brought to “tolerate” full and even toxic doses of arsenic as of some other drugs, without showing the usual physiological effects. To produce such a result it is necessary to begin with very small doses, and increase them by degrees: thus Flandin, giving at first $\frac{1}{85}$ gr. of arsenious acid to animals, gave after nine months of progressive increase, 15 gr. per diem without symptoms of poisoning.

Taylor distinguishes between "*habit*" and "*tolerance*," meaning, by the latter term, only that power of bearing large doses which is shown in certain exceptional states *without any preparation*; thus, opium may be tolerated in tetanus, alcohol in fever, and antimony in pneumonia; and with regard to the ordinary form of tolerance as *induced by habit*, he remarks that it is mainly restricted to products of the vegetable or organic kingdom—as opium, tobacco, ether, strychnine. He doubts whether any human being can obtain *by habit* any real tolerance of such mineral drugs as corrosive sublimate and arsenic; and certainly experiments on the point can never be pushed far in our own experience.

Yet, on the other hand, evidence in the affirmative does exist. I understand that at Whitbeck (Cumberland) the inhabitants habitually use a natural water which contains nearly a grain of arsenic in the gallon, and are remarkably healthy and long-lived (Chemical News, Aug., 1860). Prof. La Rue reports the case of a man who so far accustomed himself to the drug that he could take 3 or 4 gr. "without more effect than cold water" (Boston Med. Surg. Journ., 1866); but the main evidence seems curiously localised in parts of Austria and Styria, nor can it be any longer dismissed as "pure fable" (Christison) or a "Styrian theory" (Taylor), since the reports of Vögt and Tschudi in 1854 (Med. Times, ii.; Wiener med. Woch., No. 28). M. Heisch, a trustworthy witness, has recorded his personal experience to the effect that he took 3 gr. as a daily dose for many years; he began it when appointed director of arsenic works at Salzburg, with the object of protecting himself from the effects of the fumes; he retained good health, but when he attempted to leave off the drug suffered from restlessness, insomnia, faintness and finally from pulmonary symptoms (Lancet, 1860). Professor Schäfer records that $\frac{1}{20}$ to $\frac{1}{10}$ gr. is an initial dose commonly used for the first fortnight, then it is omitted for the same period, and then resumed, and gradually increased to 5 gr. or more—Heisch says that 23 gr. have been taken for a dose. Arsenious acid is the usual form, but sometimes orpiment is substituted. Dr. MacLagan saw doses of several grains swallowed, and he afterwards detected arsenic in the urine (Edin. Med. Journ., 1864); and I have myself learnt from persons at Salzburg that the habit was very common, and

have seen men who had taken from 5 to 10 gr. daily for many years with occasional intermissions, and looked robust and healthy. Near Harzburg they have the curious custom of regulating their doses by the moon—they gradually increase to the full moon, and then diminish and take purgatives of aloes; some avoid drinking with their dose of arsenic, others avoid fat, and others keep to a farinaceous diet, but the majority eat and drink anything. The practice prevails mostly, if not entirely, amongst the working classes, but is not confined to men. Its effect is said to be to increase fat, and yet to render them more equal to exertion, and especially to mountain climbing without difficulty of breathing; also to give freshness to the complexion, brightness to the eye, and general vigour to bodily function. It is agreed that much depression and emaciation occur on the withdrawal of the drug from those who are accustomed to it, and although a certain number who commence early to take it continue its use to an advanced age, yet it is said, and we can well believe it, that it does much harm, and even proves fatal in an insidious manner to many persons, especially amongst the young. (Mr. Jonathan Hutchinson denies that patients who take arsenic for a long time get fond of it, or suffer when it is withdrawn (Archives of Surgery, ii.).

We cannot depend upon securing an indiscriminate tolerance of arsenic; nothing of the kind has been reported in this country, but on the contrary many have suffered from a foolish imitation of the Styrian custom. Besredka (Ann. Pasteur, 1899) has furnished a possible explanation of this tolerance, *viz.*, the formation of an antitoxin in animals to which small doses are given continuously. It circulates in the blood serum and the giving of this serum in proportional doses prevents death from an ordinary fatal dose of arsenic. The formation of leucocytes is stimulated, which seems to absorb the drug and prevent its toxic action on other tissues. But the immunity is limited and slightly more than the lethal dose proves fatal—the same thing happens sometimes with arsenic eaters.

Effects of Arsenical Wall Papers, etc.—It is now clearly ascertained that all the serious symptoms already described may be produced in greater or less degree by arsenical emanations from wall papers and paints, hangings, dresses, ornaments, etc.; and not only from the green colours containing arsenate of copper, which have long been suspected, but also from red, drab, blue,

grey, and enamel papers generally (B. M. J., ii., 1871), and from aniline colours fixed by arsenical mordants in carpets, curtains, etc. (Taylor, On Poisons). In 1858, Mr. Phillips stated that a more than bearable heat would be required to volatilise arsenic, but Fleck has pointed out that the contact of moist organic substances (such as sizing) readily disengages arseniuretted hydrogen from Schweinfurt green (Ztschft. f. Biol., 1872), and Hamberg has verified its presence in the air of rooms (Pharm. Journ., 1874). Dr. Stevenson considers that the glue may aid in the formation of powerful poisons called *arsines*—amines in which hydrogen is replaced by arsenic. Selmi has separated one of these ptomaine-like substances, and found that its physiological action is like that of strychnine. (It is supposed that the *aqua tofana* was really a solution of an arsine which was prepared by sprinkling white arsenic on pork (B. M. J., i., 1883).) Usually, however, the injury is done by material particles of arsenical dust (Chevallier, Ann. d'Hygiène, vol. xii.). Some time ago I met with many cases of catarrh and irritation of mucous membranes which proved to be due to this cause, and I can corroborate the observations made by Mr. Clarke, of Bristol (B. M. J., i., 1873), who found that in one set of cases dyspepsia, nausea, sore throat and conjunctivitis were the prominent symptoms, whilst in another, nervous troubles, headache, irritability, prostration and restlessness were more complained of, though dyspepsia and especially a coated tongue were not absent; in a third group the prostration, headache, and nervous excitement simulated a mild typhoid. The symptoms are generally worse in a damp atmosphere, and in the evening when the room is heated. Dr. Hinds describes "depression, faintness, nausea and colic," after reading by gas-light in a green-papered room (Med. Times, 1857). Mr. Whitehead reports similar symptoms in a youth every time he occupied a certain bedroom only (B. M. J., 1858).

The real cause of chronic ill-health may be long unsuspected, and a striking case is related of the simulation of various forms of disease in one family for upwards of twelve years before their true cause was discovered in arsenical wall papers (B. M. J., ii., 1871). Leifeit reports the case of a woman twenty-six years old, poisoned by arsenical stockings; the symptoms were gastro-

enteritis, acute hæmorrhagic nephritis and eczema on both feet. Some years ago arsenic was used for clarifying candles, and serious effects were produced which still sometimes follow the use of candles coloured green. A curious cause of several cases of poisoning in the counters of money at Washington was arsenic present in the coins (Record, 1883). Arsenical fly-papers are another source of poisoning, and it has sometimes occurred from cigars and from green cigar-holders (B. M. J., i., 1879).

SYNERGISTS.—Antimony is the most complete analogue of arsenic; phosphorus also is allied in action.

The effect of small doses, upon the nervous system especially, is allied to and supported by quinine and by alkaline bromides, whilst the tonic influence of similar doses on the vaso-motor nerves (leading to contraction of vessels, at least temporarily) is allied to that of acids, astringents, ergot, and cold applications. Doses sufficient to lessen oxidation and combustion act somewhat like cyanides and other substances which prevent these processes.

ANTAGONISTS. — INCOMPATIBLES.—Diffusible stimulants, alcohol, warmth, and, according to Gubler, opium, are the vital antagonists to arsenic. Iron in the form of hydrated peroxide, magnesia calcined or as hydrate, lime, animal charcoal and astringents generally, are chemical or mechanical antidotes. Iron and magnesia have power over arsenic in *solution*, since they precipitate the poison in an insoluble form; with *solid* arsenic “they have no more effect than powdered brick-dust” (Taylor). A mixture of hydrate of magnesia and persulphate of iron is best to use, and the resulting sulphate tends to act on the bowels. The “*antidotum arsenici*” of the German and other Pharmacopœias contains calcined magnesia 7 parts in 120 of water, solution of persulphate of iron (sp. gr. 1·318) 60 parts in 120 of water: the two parts to be kept separately and mixed at the moment of administration. Such a mixture may be roughly prepared, in cases of urgency, by shaking magnesia with the *tinctura ferri perchloridi*, and then administering the bulky precipitate of sesquioxide of iron so produced: or 1 oz. of sod. bicarb. in water may be mixed with 3 oz. of the mixture and $\frac{1}{2}$ oz. given every five to ten minutes. Pure dialysed iron is not antidotal, but, according to Mattison, becomes serviceable if salt be added to it (Med. Record, 1878), since this precipitates a hydrate. Dr. Ballard,

however, speaks of the great utility of dialysed iron in those who are compelled to inhale arsenical fumes during the smelting of lead and silver ore; the bad effects are entirely dissipated by doses of $\frac{1}{2}$ oz. thrice daily: Wyeth's preparation was employed (Philad. Med. Rep., 1882). Oxide of silver (2 gr. *ter die*) has been given as antidotal in a case of chronic poisoning with neuritis, etc., to form an insoluble arseniate (Lancet, ii., 1890). Iodide of potassium is more often given in such cases.

In cases of poisoning, vomiting should be produced and promoted as early as possible; milk and demulcent drinks containing, *e.g.*, eggs, flour or fats, should be given, and large frequent doses of any of the antidotes named,—a tablespoonful of the iron compound every five to ten minutes (B. M. J., ii., 1863).

THERAPEUTICAL ACTION.—*External.*—**Lupus.**—**Cancer.**—In these maladies the caustic action of arsenic is often valuable, and the powdered drug may be used sufficiently strong to destroy diseased tissue without affecting the adjacent sound skin. For chronic superficial lupus, especially of the face, Hebra recommended “Cosme’s Paste,” containing 20 gr. of arsenious acid and 60 gr. of cinnabar in 1 oz. of rose ointment (cold cream): this is spread on linen, and applied firmly for twenty-four hours, and then renewed for the same period, a third application being made if required. I have used this with good results; at first there is little change produced, but by the second day the growth turns grey, and by the third day commences to slough, and may be separated in a poultice. Pain and œdema may occur, but can be relieved by sedatives and warm applications. Amongst many hundred cases thus treated no poisonous symptoms have been reported.

In *epithelioma*, arsenic has been long used in various combinations, as with cinnabar, calomel, or simply with an equal part of mucilage. The paste commonly known in Ireland as Miss Plunkett’s is prepared with arsenious acid, sulphur and two species of *ranunculus*: it often acts powerfully.

As already stated, caution is required in the external use of arsenic: not that it should be applied in a more diluted form, for then its absorption would be even more probable, but only a limited area—not more than one square inch—should be covered at one time.

Nævus.—Mr. W. G. Beatty and Dr. Blair have both recorded cures of nævus, by the local application of liquor arsenicalis every two or three days for three to five weeks (B. M. J., ii., 1883, and i., 1884); diarrhœa may occur.

Dental Surgery.—Arsenious acid is in daily use for destroying the nerve-filaments in a tooth-pulp before filling the cavity, and it is still considered one of the best agents for the purpose. It is true that violent symptoms have sometimes followed its use, which always needs caution: still osteitis and its accompanying pain might occur after any destructive application, and we may fairly consider that $\frac{1}{16}$ gr., especially when combined, as it usually is, with a little morphine, is free from serious risk.

Rheumatoid Arthritis.—Baths containing from 15 to 30 gr. of arseniate of sodium, with a few ounces of the carbonate of sodium, have been well spoken of by Dr. Guéneau de Mussy, as relieving both the pain and the deformity consequent upon rheumatoid arthritis, but must be used with great caution. There is some evidence in favour of the internal use of the remedy for this malady (*v.* p. 508).

THERAPEUTICAL ACTION.—*Internal.*—The therapeutical powers of arsenic, which are many and various, may be traced along the same lines as its physiological action, and grouped as follows: (*a*) general diseases, such as intermittent fever, phthisis, struma, lymphoma, anæmia, chronic rheumatism, diabetes; (*b*) more specially nervous disorders, neuralgia, asthma, chorea; (*c*) disorders connected mainly with capillary congestion, cerebral, renal, uterine, or cutaneous; (*d*) disorders affecting chiefly mucous membranes, coryza, chronic bronchitis, dyspepsia, gastric catarrh, vomiting, diarrhœa, English cholera, gastric ulcer.

Intermittent Fever.—*Ague.*—Long used as an empirical remedy for ague in the East, its more scientific employment dates from Slevogt of Jena, in 1700.¹ Condemned by Baron Störek, it

¹ Of the older writers on this subject, Melchior Frick and the two Plencitz, of Vienna, deserve mention. The former says: "Experientia nos docebit, arsenicum in febribus intermittentibus adhibitum omnes eas dotes possidere, quibus optima remedia prædita esse debeant" (*Paradoxa de Venenis*, 1710). Of the practice of the latter at the Orphans' Asylum, Harless reports: "Ejusque (arsenici) usu in millenis fere febrium intermittantium casibus, raro frustratos fuisse affirmant."

was re-introduced by Dr. Fowler of Stafford, in 1786, after experience of the effects of a "patent ague drop" which contained it; and again condemned by Broussais. Its value was finally re-established by Boudin, in 1842, after a prolonged experience in Algeria (On Intermittent Fevers). The English physician reported several hundred, but M. Boudin 4,000 cases, almost all successful. The former was accustomed to press the remedy to its "operative" or physiological effects; the latter aimed at inducing "tolerance," commencing with fractional doses every quarter-hour, so as to introduce as much as possible into the blood, and to "substitute an arsenical for a paludal saturation." The names of Sistach, Millet, Frémy, and Isnard are associated also with records of large numbers of successful cases, whilst opposite experiences may be found in the works of Gintrac, Oesterlen, and G. Sée.

In 1860, Mr. J. Turner reported such favourable results with $\frac{1}{2}$ dr. doses of Fowler's solution, given every second hour for four or five doses, that the Director-General recommended the plan to army officers (Med. Times, ii., 1871), and Dr. Chappell supported it with an account of 80 cures out of 140 cases (Med. Times, i., 1861). These observers found, as did Fowler, Rayer and others, that much better results in curing ague were obtained with large doses, as of 30 to 40 drops, than with ordinary, full or unusual doses up to 20 drops; but Sistach and others observed that as soon as the fever ceased, the system ceased to "tolerate" such quantities and there is always a possibility of the remedy doing harm. A case has been recorded of a physician aged fifty, who took 12 drops of Fowler's solution twice daily for about three months with apparent benefit to the intermittent, but he suffered from diminished secretion of urine, colic, tenesmus, weak heart, etc., and died rather suddenly with vomiting and syncope; his attendant traced his symptoms to arsenic, but an ordinary cerebral attack—i.e., independent of arsenic—is not excluded by the history given (Med. Record, 1879).

We cannot doubt that arsenic, suitably administered, is an effective remedy for ague, but on comparing it with quinine, and allowing for a percentage of spontaneous recoveries from mild attacks, we conclude that the latter remedy is still to be preferred for severe and acute cases, and in "pernicious" or "malignant" forms; also it usually acts better in tertian ague. When, how-

ever, it has failed to cure such cases even in excessive or long-continued doses, or when the malady is of moderate severity, subacute or chronic, especially when of quartan type and accompanied with marked œdema and prostration, then arsenic is specially indicated. The element of risk may be much lessened by careful attention to the urine and the general symptoms.

Splenic or hepatic hypertrophy may be another indication for it, as Boudin suggested. It is good in malarious cachexia (when quinine often renders but little service), also when jaundice is present; further it has some prophylactic power, and assists in preventing relapses. Dr. Pfeifer has recommended the injection of Fowler's solution into the substance of the spleen, when it is enlarged as a result of ague. In one case a syringeful was injected ten times in the course of eight weeks. This procedure is, however, dangerous when there is any hæmorrhagic or leucocythæmic tendency (Cbl. f. d. gesamt. Therapie, 1884).

I have records of nineteen cases of severe chronic ague of the quartan type, all successfully treated by arsenic. Most of the patients were Americans who had taken quinine very largely, being in the habit of carrying it in their pockets and taking from 5 to 20 gr. whenever they fancied an attack was impending. Many of them had clean, red, irritable tongues, and were suffering from œdema or anæmia; in most of them the spleen was enlarged, and in some the liver. I prescribed the liquor arsenicalis in 5 to 10 min. doses thrice daily, and the result of this treatment was uniformly good.

As regards the prevention of relapses, Hirtz, judging from 120 cases, found quinine and arsenic nearly equal; probably the best results may be obtained by a judicious combination of them both, full doses of the former being given to ward off an impending paroxysm, and arsenic in the intervals: this mode of treatment I have frequently adopted with success. Professor Gubler uses arsenic in ague as a sedative, and "reconstituant indirect," after the fever has subsided, and connects its efficacy against relapses with its permanent deposition in the tissues. There is some evidence of its use as a prophylactic (B. M. J., i., 1889); both quinine and arsenic have been credited with an "antizymotic" power of destroying malarial germs in the blood.

Phthisis.—For the employment of arsenic in chest diseases

we may go back as far as Dioscorides, who states that "sandrach (probably the sulphuret) is given to patients suffering with suppuration in the lungs, and mixed with resin is inhaled in vapour for obstinate cough." Dr. Beddoes used it early in this century, and recently the value of the drug in certain stages of tuberculous phthisis has attracted renewed attention. Hérard and Moutard-Martin have especially recorded good results from it in relieving the pulmonary congestion and the general pyrexia of early stages; at the same time the latter physician observes that it is most efficacious when phthisis assumes a *slow* torpid course, acute tuberculosis not being modified by it. "It has a reconstituting action, and modifies secondarily the pulmonary lesion" in suitable cases (Lancet, i., 1868).

Before softening of tuberculous deposits has taken place, I have found arsenical solution in 2 or 3 min. doses three times daily give particularly good results; it is well to combine it with a course of cod-liver oil and also, if possible, change of climate, and it should be continued for weeks or even months. I agree in general with the account given by Isnard (which is still more favourable), for he found it relieve profuse sweatings, improve appetite, and promote in some favourable cases not only healing of cavities but absorption of tubercle (Bull. de Thérap., t. lxxvii.). It controls diarrhoea in these cases in a very marked way, and the arsenate of iron has been found to be particularly useful in preventing night sweats.

Since Koch's discovery of the tubercle bacillus, the theory which has been advanced to explain the action of arsenic in phthisis is that it is preventive rather than curative, the bacillus not being able to grow in a medium in which arsenic also finds a place, but recent observations seem to show that any amelioration is due to improved appetite rather than to a lessening of the growth of tubercle. Thus when G. Kempner gave arsenious acid in doses which he increased to $\frac{1}{4}$ gr. daily,—the appetite was improved and the fever relatively lowered. H. Lindner found that the sweating and expectoration were lessened; whereas R. Stinzing, who treated sixteen cases with similar doses, had unfavourable results in all (Record, 1883).

Cersoy traces to arsenic an effect which has been also attributed to it in bronchitis, and which really accords with what we

know of its physiological action, *viz.*, the lessening of congestion both in the bronchial mucous membrane and in peri-tubercular lung-tissue; thus he finds that it benefits hæmoptysis (Gaz. des Hôp., 1869). Professor Stillé thinks it probable that any benefit conferred in phthisis is due to an influence upon the accompanying bronchitis.

Massart is almost alone in his recommendation of an *arseniate of gold*, which, in doses of $\frac{1}{16}$ to $\frac{1}{8}$ gr., he found useful even in advanced cases (Rev. de Thérap., 1860). The arseniate of strychnine is a more recent introduction in the form of a solution of $\frac{1}{2}$ per cent. in vaseline; from 4 to 15 min. were given subcutaneously daily to four cases which improved (Lancet, i., 1889). The general opinion of French observers, however, would restrict the value of arsenic to early stages, or to the relief of certain symptoms: thus Nonat agrees as to the good results of $\frac{1}{16}$ to $\frac{1}{8}$ gr. doses given early in the malady, and finds that in later stages, especially in the cases mostly seen in hospital practice, benefit is exceptional (Lancet, i., 1870); and Trousseau, whilst recording improvement as to diarrhœa, hectic, expectoration and cough, does not speak of cures, but of the gradual development of the malady and the formation of fresh tubercle. He prescribed cigarettes containing arseniate of sodium and pilules of arsenious acid.

I do not find many English observations on this subject, nor has this medication for phthisis been generally adopted amongst us. The late Dr. C. J. B. Williams says: "I have tried it only to a limited extent. . . . It has only seemed to be useful in chronic cases with asthmatic or cutaneous complication, but well deserves further investigation" (Pulmonary Consumption, 1st ed.). Dr. Ringer suggests that allowance must be made for a natural improvement in some forms of phthisis, but has himself seen instances of recovery under its use "in children with general tuberculosis," and "in adults suffering from subacute and chronic forms"; he corroborates also, to some extent, the statement that it will reduce temperature. Dr. Sanger reports, from the convalescent hospital at Seaford, favourable results in a large number of phthisical patients to whom he gave 5 min. doses of Fowler's solution, but he generally combined it with iron or hypo-phosphites (Lancet, i., 1869). Dr. Leared based a favourable opinion upon the observation of nine cases, but finds the remedy "trying to the

digestive system" (Med. Times, i., 1863), and this I believe to be a very common result, owing to the dose prescribed being too large. It has been given with apparently good results in tuberculosis of bone and has seemed to act as a valuable temporary tonic in Addison's disease (*v. Cacodylates*, p. 533).

Strumous Ophthalmia.—In chronic cases of glandular enlargement, pallor and anæmia, occurring in subjects with the ordinary evidences of struma, arseniate of sodium is often beneficial; it improves the appetite and colour, seeming to stimulate the lymphatic and arterial systems. I have frequently known Fowler's solution prove serviceable in strumous ophthalmia, giving relief to the redness and swelling of the lids, as well as to conjunctival congestion and excessive secretion; it has seemed also to help in cicatrising ulcers, and in diminishing the exudation which would produce leucoma. Mr. Oglesby speaks of its special value in that form of strumous ophthalmia which is accompanied by herpes (*Pract.*, vol. ii.).

Strumous Cachexia. — Lymphadenoma. — Professor Bouchut restricted the value of arsenic in glandular disease to cases where this was superficial and limited, and where cachexia was not present, but later experience has proved the remedy to be more generally useful. I have seen it of much service, especially when combined with iron, in relieving cachexia, and Billroth has recorded a remarkable case — that of a woman, aged forty, in whom the cervical, axillary and other glands, as well as the spleen were affected, who recovered under Fowler's solution, taking 5 to 20 drops for a dose. Dr. Winwarter records good results in cases of lymphadenoma or Hodgkin's disease. Under the use of arsenic continued for three or four months or more, and also injected into the tumours, they have disappeared at least for several years, and the patients have become convalescent. It is recommended to begin with 5 min. of Fowler's solution and 5 min. of tinct. ferri perchloridi night and morning, cautiously increasing the dose up to 30 to 40 min., or to the production of physiological effects (*Stricker's Jahrb.*, 1877). Dr. S. Monckton has recorded a remarkable case of cure of the same malady—he gave pills containing $\frac{1}{13}$ gr. of arsenious acid, which were coated with keratin so as to ensure their being digested in the intestine and not in the stomach,—the result

being that in the course of two months the tumours had almost disappeared (B. M. J., ii., 1885). E. Romberg has a similar case (B. M. J., Ep., i., 1892): my own experience has not been so favourable.

Chlorosis.—In this disorder I have seen arsenic act well, and it seems to increase the good effect of iron: it has been strongly recommended by Isnard (*cf.* Lancet, i., 1885).

Pernicious Anæmia.—This malady, first described by Dr. Addison as “idiopathic anæmia,” has sometimes proved amenable to arsenic. Dr. Byrom Bramwell has recorded a typical case, which was carefully treated in hospital for three weeks with full doses of quinine and iron, and later phosphorised cod-liver oil, and yet steadily got worse until 2 min. of liquor arsenicalis were given thrice daily, the other remedies being stopped. The dose was gradually increased to 16 min. thrice daily, and “the after-progress of the case may be described as one of slow but uninterrupted improvement” (Med. Times, ii., 1877). The same physician has published an analysis of forty-five cases from which he concludes that the patient’s power to take arsenic is the most important point in prognosis, and it may even prevent relapse. Dr. M. Finney has reported three well-marked cases of “pernicious anæmia,” two of which recovered under arsenic, and he calls it “one of our surest tonics to the blood-making organs” (B. M. J., i., 1880). Dr. Withers Moore treated, at the Sussex County Hospital, a woman aged thirty-two, who showed characteristic symptoms of the malady nine months after a bad confinement, and after frequent epistaxis: she was extremely pale and feeble; the red corpuscles of the blood were few, small and altered in shape, the white corpuscles not increased in number. For the first three months of her stay in hospital iron was tried in various forms without benefit; for the last two months she took 3 min. doses of Fowler’s solution, and ultimately left convalescent. The case was typical with occasional pyrexial attacks raising the temperature to 104° F., and even on one occasion to 106° F. These attacks were controlled by full doses of quinine, but excepting this, arsenic was the only medicinal agent used during the stage of recovery (*cf.* Lancet, ii., 1891). Since this date further research, for which we are largely indebted to Dr. William Hunter, has shown the malady to be probably a toxæmia with hæmolysis, and

to need antisepsis, but he is satisfied that this should be supplemented by the use of arsenic, "the great value of which is fully established". He notes that Dr. Byrom Bramwell was led to use arsenic by noting the constant presence of fatty degeneration of the heart which it had the power of improving—though generally for a time only. It is best given at first in small doses, 2 drops of liquor arsenicalis thrice daily; this may be increased to 10 or even 20 drops, but he (Dr. Hunter) is not satisfied that the larger doses act proportionately well (Treatise, 1901). (In my experience of several cases recently no benefit was obtained from the drug in this form or as cacodylate—but they were in advanced stages.)

Anæmia.—Dr. Lockie has published illustrations of the value of arsenic which he says is a "blood and cardiac tonic in anæmia" (B. M. J., ii., 1878). Dr. W. Osler has seen arsenic of much service in puerperal anæmia, and amongst other cases reports a severe one in which iron had failed, and the patient was subject to diarrhœa and vomiting and could not sit up without fainting, but recovered well under moderate doses of this drug (Internat. Journ., 1889).

In **Leucocythæmia** some remarkable cases of benefit have been observed at University College Hospital, from doses of 60 to 100 min. daily, with occasional occurrence of pain and diarrhœa (Lancet, i., 1892).

In **Secondary Syphilis** it is sometimes useful (B. M. J., ii., 1891).

Chronic Rheumatoid Arthritis.—In this condition the value of arsenic has been frequently shown since its recommendation by Haygarth and the elder Bardsley in Manchester (Medical Reports). I quite agree with the latter physician in his opinion that the remedy promises well in cases where the vital powers are diminished, and the ends of the bones, the periosteum, capsules and ligaments are swollen; under the continued use of the drug I have known the joints return to their natural size. Sir R. Christison records a similar experience in cases of "nodosity of joints," and Dr. W. Begbie describes fully the case of a man with swellings of the small joints of the hands and feet, very painful, especially at night and in changeable weather, and almost preventing any movement. The patient had received no benefit from a long trial of many remedies, but under a course of Fowler's solution recovered the use of the joints, and was able to resume his work.

Dr. Fuller speaks highly of the remedy in "chronic rheumatism," and especially in rheumatic arthritis, when the skin is dry and inactive and the patient chilly (*cf.* p. 501).

Diabetes.—Sir Walter Foster says that he has seen arsenic act well in improving nutrition and lessening thirst, but not in diminishing the excretion of sugar; hence he considers it acts mainly by saving the waste of albuminous tissues (Clinical Medicine). Dr. Bartholow finds it beneficial in thin subjects with defective assimilating power, but not in the "stout subjects" who suffer from boils and carbuncles. I have frequently prescribed it both for stout and thin subjects with good results, but as a rule it only acts as a palliative, checking the sudden emaciation and prostration and relieving the excessive thirst and the dryness of the mouth. In several cases it lessened for a considerable time the quantity of urine and urea, and in some instances appeared to diminish the sugar; it certainly in nearly all cases improved digestion (*cf.* Med. Record, 1883-84). It is of special use in diabetes after the excretion of sugar has been reduced by diet and codeine, and when neuralgia is a complication.

Neuralgia.—For this arsenic holds a chief place amongst remedies. Dr. Fowler's original reports contain several conclusive cases, although their relief seems somewhat counterbalanced by the gastric symptoms which he did not scruple to produce. Maculloch, in a well-known Treatise on Malaria, speaks highly of arsenic in confirmed neuralgia; and Romberg, a still higher authority, notes its value, especially in facial neuralgia and in forms connected with uterine or ovarian disease; anæmia is also an indication for its use, and full doses are necessary. Amongst modern French observers, Isnard reports many cures of various typical neuralgiæ, and of ordinary neuralgic pain (*De l'Arsenic dans la Pathologie du Système Nerveux*). M. Boudin found it invariably succeed in periodic—probably malarial—forms, and M. Cahen has published sixty-five successive cases with almost uniformly good result (*Archives de Méd.*, 1863). Barella devotes a long chapter of his work in praise of arsenic to its value in nervous disorders (Brussels, 1866). Of modern German writings on the subject we may quote Erb, who adopts mainly the views of Isnard, considering the remedy as "a neurasthenic tonic" with the power of restor-

ing order to disturbed action. He places it in the first rank amongst specific remedies, not only in recent and periodic cases, but also in chronic forms of purely idiopathic neuralgia. In the facial variety and in sciatica he endorses its high reputation, but in the latter affection places its value below that of turpentine (Ziemssen's *Cyclopædia*). In the treatment of sciatica, arsenic is most suitable when the pain is deep-seated, worse at night but with occasional marked intermissions, and temporarily relieved by hot applications.

Sir Thomas Watson notes the great use of the drug in hemi-crania or migraine, and successful results in various cases from full doses of Fowler's solution were published by Mr. Thomas Turner of Manchester (*Med. Times*, ii., 1861). Dr. Anstie, in his *Treatise on Neuralgia*, speaks of arsenic as "one of the most powerful weapons in the physician's hands." He looked upon it as calculated to improve the quality of the blood, to stimulate the nervous system, and oppose periodic (disordered) action. The same physician also pointed out the connection and frequent interdependence of gastralgia, angina pectoris and asthma, as neuroses of different branches of the vagus, and he illustrated this connection by the history of families in which these affections occurred in alternate generations. From my own extensive trial of arsenical medication in neuralgiæ and especially of the fifth pair of nerves, I also conclude it to be almost our best remedy, particularly when the pain felt is of burning stinging character, and when the attack is connected with malarial influence.

Gastralgia is a term properly restricted to painful affections of the stomach unconnected with organic disease or inflammation, or even with ordinary dyspepsia. Such cases are not very frequent or very easy of diagnosis, but occur, especially in females, during youth and at the climacteric period, and are accompanied with other evidences of impaired nervous power: sometimes they are reflex (being connected with uterine derangement), and sometimes malarial (Niemeyer). Trousseau describes attacks dependent on exhaustion, and Budd on alcoholism. The neurotic character is evident when, as in Dr. Anstie's cases, the malady alternates with attacks of asthma, and Tessier (*Journ. de Méd. de Lyon*, 1848) and Anstie agree in estimating highly the value of arsenic

in such cases. Dr. Clifford Allbutt speaks of gastralgia as readily distinguishable from dyspepsia, and describes sudden violent pain in the gastric region and back, and another form less severe and more gradual in onset, and irregular as to time, and unconnected with eating (Liverpool and Manchester Reports, 1873). Dr. Leared also restricts the term to a neurosis with cramp-like, fixed or diffused pain, coming at irregular intervals, often at night, accompanied by prostration, followed by bilious vomiting, and occurring generally in middle-aged persons from mental anxiety (B. M. J., 1867). Such cases furnish a special indication for arsenic, and Allbutt says it is, for such, the "king of remedies," only I would interpret "gastralgia" in a wider sense, and, without attempting to diagnose it rigorously from dyspepsia, would include under the term many forms of painful stomach disorder, neither inflammatory nor organic. In this sense it is used by Barras (*Traité sur les Gastralgies*) and other French writers, and a reference to the observers I have named will show that in their cases such symptoms as flatulence, vomiting and pain increased by food were often present, and although the tongue might be clean, and certain dyspeptic symptoms absent for a time, yet they would readily occur, and to restrict the use of the remedy to purely nervous attacks is needlessly to limit its value: we shall see, in fact, that in gastric catarrh it is an excellent medicine.

The following is one of many cases of climacteric gastralgia, complicated with dyspepsia at times, and relieved by arsenic. Mrs. S., aged forty-three, thin, describes very acute pain in upper front chest, and sometimes in the back about the second dorsal vertebra and interscapular region, almost constant, sometimes easier after food, sometimes worse: no vomiting, pyrosis, or hæmatemesis: no physical signs in the chest, no evident hepatic disease, and bowels regular. Pulse 64. Youngest child is five years old; menstruation lately irregular and profuse; has some prolapsus and back pain, distinct from her gastric pain. Nursed her husband anxiously for two years, during which time the pain first came on, and it is now often induced and always aggravated by mental worry, of which she has much. The pain is generally worst on waking about 2 A.M.; gets better after breakfast and worse again in the evening: it is sometimes referred to the epigastrium and left shoulder, and described as "like a hot bar pressing," or "like

a hand gripping." Arsenic relieved the pain more effectually than any other remedy tried, and although during attacks of painful digestion *nux vomica* given before food did much good, the steady use of arsenical solution was, according to the patient's own statement, always the most effective.

Angina Pectoris.—This malady, even if primarily dependent on calcareous or other degeneration, is mainly a neurosis, and nearly 100 years ago was successfully treated with arsenious acid by Alexander. Philipp and others record very striking benefit in cases that had been rebellious to quinine (*Syd. Soc. Year Book*, 1865-66), and I can fully bear out Dr. Anstie's testimony to the great relief given by arsenic to patients suddenly attacked with spasmodic pain, embarrassed cardiac action, and sense of impending death: he found the medicine reduce the severe attacks to little more than a tightness of the chest, and it availed most in anæmic patients, suffering from overwork and anxiety.

Spasmodic Asthma.—**Asthma Nervosum.**—In this, the third of the trio of vagus neuroses, Dr. Anstie also records good results, but others had preceded him in this observation. We have already noted its improving the breathing power of mountaineers, and this had suggested to Kappel its use in asthma. Rilliet spoke highly of it, and also Trousseau, who used it partly in cigarette (*Bulletin*, 1861). Dr. Leared recommended a form of cigarette containing $\frac{1}{2}$ gr. of arsenic with a little nitre (*Lancet*, i., 1863). Dr. Thorowgood, whilst laying stress on the frequent gastric causation of asthma and its special treatment, has found arsenic useful in gouty and rheumatic cases, and Riegel notes its value in preventing relapses in "bronchial asthma," and in the form which occurs alternately with some cutaneous diseases, known as "herpetic asthma" (*Ziemssen's Cyclopædia*, iv.). Dr. Berkart seems to attribute any good effect more to improving the nutrition, appetite and digestion, and to negative any specific virtues (*On Asthma*, 1879), but since then many cases of direct benefit have been recorded. One method of its application is by spray, which has been used with much success by Wistinghausen, and more recently by Dr. Wahlstuch, of Manchester: the latter used arsenates of potassium, sodium, or ammonium in spray containing $\frac{1}{8}$ to $\frac{1}{2}$ gr. at first twice daily and by degrees less frequently; his excellent results were, however, rendered less

certain as clinical proof by the concurrent use of galvanism and other remedies (B. M. J., ii., 1877).

Martelli has recently reported immediate relief to an asthmatic paroxysm from the hypodermic injection of Fowler's solution (1 part to 2 of water): the cure was complete after 2 dr. were used at intervals in divided doses in this manner (Med. Record, 1878). Arsenic acts best in simple cases of idiopathic or spasmodic asthma of neurotic origin; but it has done well in cases dependent on bronchitis, emphysema, or cardiac disease. In cases due to compression of the air-tubes by enlarged glands it may be carefully tried (Berkart).

The solution should be administered in 5 min. doses, three or four times daily, during the intervals between the attacks, and should be persevered with for many weeks, and in some instances for months, but the dose under these circumstances should be decreased. For upwards of twenty years I have used it in asthmatic cases with unmistakable success. It has also been of value in relieving the dyspnoëic attacks associated with emphysema; also in whooping cough, in hay fever and in paroxysmal sneezing from any cause.

Chorea.—From the time of Girdlestone, 1806 (London Med. Phys. Journ.), there has been much evidence as to the value of arsenic in chorea. Reese of New York, in 1840, describes cures in 200 children under 6 to 8 min. doses of Fowler's solution twice daily; Rayer corroborates his results (Union Méd., 1847). Romberg calls it "the foremost remedy," when given in sufficient doses (Klin. Ergebnisse, 1856), and records severe cases—one of eight years' duration, rebellious to many other medicines, but cured in two months by arsenic; and another patient had been unable for six months to stand or speak, having such violent choreic movements, yet recovered after two months of treatment with 4 min. of Fowler's solution thrice daily. The well-known names of Aran, Henoch, Steiner and Barthez may also be cited as authorities in the same direction, and continental work with regard to it is fully summarised in the thesis of M. Gellé (Hôpital des Enfants, Paris, 1860). He quotes cases where improvement was manifest within eight days, three days, and even forty-eight and thirty-six hours respectively, but concludes that from five to eight days is an average period. He gives also

several cases equal in severity to those of Romberg and expresses similar conclusions, *viz.*, that some failures of the remedy may be expected in neurotic sanguineous subjects, but great success in the lymphatic, chlorotic, and cachectic. M. Aran urges the rapid attainment of a full dose rather than a long-continued small one (Syd. Soc. Year Book, 1859). Exceptional success has been obtained with doses of 15 min., twice daily, continued for ten or twelve doses without any recorded ill effect (Lancet, i., 1893). Dr. Steiner, on the other hand, commences with 1 min., and considers 8 min. should be the maximum daily dose: within fourteen days he expects improvement.

Amongst English observers there is a large preponderance, though by no means a consensus of opinion in favour of arsenic as the best remedy for chorea. Gregory, Babington and many others have all written to this effect. Dr. Radcliffe suggested its hypodermic administration in some cases of chorea, where it produced gastric derangement, and he employed this method with signal benefit. He diluted the dose of Fowler's solution, 1 to 12 min., with an equal quantity of water (Reynolds' system, vii.). The hypodermic method was subsequently used by Schmidt, Perrorid, Widenhofer and others with good effect. Dr. Anstie records the severe case of a girl who had been treated in hospital with camphor, cod-liver oil, bromides and zinc, also with succus conii in the dose of many ounces daily, yet without relief, and who recovered under 3 to 5 min. doses of Fowler's solution: he used at the same time ether spray to the spine, but this application has not proved itself of such power as he then thought it (Pract., June, 1874). Dr. Ringer considers arsenic by far the best remedy in simple chorea; he remarks that failure may be owing to smallness of dose, also that children above five years of age bear nearly as much as adults, and that girls seem to require more than boys. Dr. Eustace Smith and others have also specially noted the tolerance of choreic children for arsenic, and the necessity of full doses to secure success (B. M. J., i., 1875). Dr. Seguin (Record, 1882) equally considers that the dose of arsenic given in chorea and some other nervous diseases is often too small; he gives from 3 to 30 min. of Fowler's solution three times a day, and finds that children especially show a remarkable tolerance for the drug; if any toxic symptoms appear,

an intermission of the drug for forty-eight hours is necessary. In my own practice for upwards of thirty-five years, I have often known arsenic fail to cure simple chorea, but many of my cases were severe and incapacitated for the ordinary duties of life; 2 to 5 min. of Fowler's solution thrice daily has been the dose usually prescribed by me. I have frequently observed that no permanent good effects follow until the development of slight physiological symptoms, but care must be exercised, as peripheral neuritis has been caused by its administration to choreic patients (*cf.* Cacodylates).

From the above quotations and remarks, though they represent an ample experience, we must not conclude that the value of this remedy is equally acknowledged by all. The counter-claims of iron, of zinc, of belladonna, etc., are urged by some observers, and the natural tendency to cure of the malady under favourable conditions is still more strongly insisted upon by others. Vogel classes arsenic with "a number of empirical remedies that are more praised than curative." Sir Samuel Wilks attributes much more importance to rest (*B. M. J.*, ii., 1876), and Dr. Sturges includes arsenic amongst a number of other "useless medicines" (*Lectures on Chorea*, 1876). In estimating the value of any remedy, we are constantly met by the difficulty of proving how far we have affected the course of nature; this difficulty is not greater with the present medicine than with others, and even allowing that chorea will recover with proper rest, food and management, yet I am of opinion that arsenic will usually promote and quicken the cure. Judging from private practice and from hospital in-patient records, a large number of cases recover whilst taking arsenic, either far more quickly than in the ordinary course of the malady, or (making the contrast more striking) do so after many remedies have been tried without effect under equal conditions. The ordinary duration of a chorea well managed, but without medicines, has been stated as six to eight weeks; if it continues three months Jaccoud considers it chronic, almost incurable, yet we have already quoted and have seen many cases that improved within two or three days, and recovered within three to five weeks, and we have quoted also instances of cure after a duration of many years. In markedly anæmic patients we might prefer iron, or at least combine

it (Levico water contains this combination ; Lancet, i., 1890) ; if sexual excitation were present, as in the case of some girls at puberty, we might substitute bromides or *antispasmodics* ; acute or marked rheumatic symptoms would also modify the treatment, but allowing for these we still consider arsenic a valuable agent in all varieties of the malady.

Epilepsy.—The older writers, such as Alexander and Duncan, have recorded cases of this disease cured under arsenical treatment, and there seem to be some cases specially amenable to it—for instance those that are connected, however remotely, with malaria. Dr. Bristowe recorded the case of a lad of fourteen, anæmic, but free from evident organic disease, who had suffered severely from epileptic attacks, mainly nocturnal, for about two years, and afterwards from attacks day and night, so frequently that he remained unconscious for some days, and was apparently dying ; being roused, however, from this condition, he remained partly paraplegic, and the fits, preceded by screaming and by an aura in the feet, recurred on movement of the legs, or on excitement ; for nearly a month he took zinc sulphate in increasing doses with valerian, but remained in the same state, sometimes disturbing the ward for a whole night ; he was then ordered 5 min. doses of Fowler's solution thrice daily, and although he was not made aware of any change in treatment, the attacks ceased at once for many days ; they recurred for a time under excitement, and the numbness of the lower limbs persisted for some days ; eventually, however, he got well (Med. Times, i., 1862).

Dr. Clemens (Frankfort) strongly recommends a "liquor arsenici bromidi" (vel bromatus) which he has used for twenty years in the treatment of epilepsy of all varieties with much success ; it has relieved even in cases connected with thickening of the skull and congenital malformation (Med. Record, 1877). This preparation is said to be more reliable than Fowler's, and to act well without increase of the daily dose : it is made by boiling potassium carbonate and arsenious acid, of each 1 dr. in $\frac{1}{2}$ pint of water : making up to 12 oz., adding 2 dr. of bromine, and mixing thoroughly.

Cerebral Congestion.—Thrombosis.—As a preventive of hemiplegia from cerebral thrombosis, the remedy has a traditional reputation. Lemare-Piquot relates marked relief to giddiness, sense

of oppression, and other premonitory symptoms, both in his own case and that of five other persons about sixty years of age. He recommends from 4 milligrammes to 1 centigramme daily for about a month, taken at meal-times. Hirtz has had reason to think it efficacious in obviating atheromatous degeneration (Nouveau Dict.). It is extremely useful when there is puffiness below the eyes, drowsiness and mental torpor, with sluggish venous circulation, and suspicion of commencing atheroma. By a similar action, perhaps, it benefits the melancholy of those suffering from hypochondriasis, especially aged persons.

Cardiac Weakness.—Mitral Disease.—Venous Congestion.—For such conditions arsenic is often found serviceable, and under its use dyspnœa on exertion, palpitation, faintness and œdema of the extremities have all improved.

When *intermittent pulse* occurs from cardiac weakness, whether of temporary character or dependent on degeneration or mitral disease, arsenic is often serviceable, as it is also in the same condition when due to nervous conditions. Darwin relates a case of “regular intermission” cured by 4 min. doses of a saturated solution of the drug. I have seen numerous cases cured by the continued use of 2 to 5 min. doses of Fowler’s solution after each principal meal. Under such circumstances it often produces a marked diuretic action, which is quickly followed in many instances by disappearance of any swelling, and by relief of the dyspnœa, faintness and palpitation.

Albuminuria.—The influence of arsenic upon this condition is well worthy of further investigation. A case of “acute renal anasarca” in a woman aged nineteen is briefly recorded from Dr. F. Farre’s practice (Lancet, i., 1862); six weeks after the commencement of the attack she developed psoriasis, for which Fowler’s solution was prescribed, and under its influence the albumin disappeared, and the patient gained flesh and strength. I have for many years used it in albuminuria following scarlatina; it removes the dry inactive condition of the skin, checks thirst, and causes a copious flow of urine, which gradually becomes less loaded with albumin; should dyspnœa be present the remedy, if acting well, quickly relieves it, and the œdema of the face and body disappears. In 1876 a case came under my care of chronic character, occurring in a builder, aged forty-three, of dissipated though

hard-working habits; he had general anasarca and epileptiform convulsions, which were relieved for a time by laxatives, but the amount of albumin was uninfluenced by them, or by a long-continued use of iron. Fowler's solution was substituted, and the albumin diminished and soon ceased to appear; then, omitting the medicine, a relapse occurred; this again yielded on resuming the remedy, and the albumin, anasarca and convulsions all disappeared, and in two to three months the patient's health was quite re-established, and he has since been quite well. I have also treated by liquor arsenicalis, with excellent results, numerous cases of *temporary or intermittent albuminuria* dependent on imperfect digestion.

Sir Lauder Brunton (Pract., June, 1877) remarks on the important distinction between "true and false" albuminuria, including under the latter term not only the presence of albumin from pus or blood, but also the so-called Bence Jones' albumin,—egg-albumin—the albumin absorbed from the intestine after imperfect digestion: it is a case of the latter kind that is recorded by him as being much benefited by arsenic, and it had several peculiarities. The patient was aged thirty-three, sallow and thin; the first symptom was great fatigue on exertion, then albuminuria was noticed (on examination for life insurance): it was at first present only during the summer; it came on after work and ceased on rest; it ceased also under strychnine (but this caused headache and sickness), and during quiet residence at the seaside. Fatty food brought it on, and meat taken in the morning, not when taken at night. Quinine and phosphoric acid at once increased the quantity, but rigid adherence to a farinaceous diet quite controlled it, and there were other evidences of its direct connection with digestion. After many years of treatment including milk-diet, sea-voyages, digitalis, hydrarg. c. creta, etc., 3 min. were ordered of Fowler's solution at mealtimes, "and almost at once the albumin disappeared, and the patient was able to do much more work than usual, without its return." Later, the medicine was changed for hypophosphite of soda, and the albumin returned, to cease again on resuming arsenic. Pancreatin, which aids in the solution of albumin, was also found beneficial, and it is clear that this affection should be classed under faulty digestion or assimilation rather than as renal disorder. The

special form of chronic albuminuria in which I have proved its value is that dependent upon venous congestion, mitral disease, or emphysema after the right ventricle has begun to yield, but it deserves a trial also in cases where the renal structure and epithelial lining are affected. I have carefully watched many of these latter cases in which the beneficial action of arsenic was marked.

Uterine Congestion.—This condition may accompany either menorrhagia or amenorrhœa, and that arsenic may remedy either symptom is therefore not contradictory. In the former, the catamenia being too copious and too frequent (leucorrhœa often occurring in the intervals), and the patient becoming weak and anæmic, small doses of from 2 to 6 min. thrice daily will be found to lessen the flow and to improve appetite and general health.

Amenorrhœa.—When this depends upon congestion or torpor of the uterus, or is connected with anæmia or chlorosis, I have known arsenic succeed well, and have several times found that when iron preparations had been taken without marked result, the addition of arsenic was quickly followed by relief—it seemed to act as a regulator of the circulation and uterine tonic, but permanganate of potassium and other remedies are more reliable.

Hæmorrhoids.—The efficacy of arsenic in this form of venous congestion has been sometimes well shown; thus in one case, a gentleman had suffered for many years, and had undergone cauterising and other operations, when this remedy was given to him for hay asthma, and he found his hæmorrhoids to be more relieved in a few days than under any other treatment; relapses occurred more than once, but always yielded in a few days to 8 min. doses of Fowler's solution (Parvin, in Braithwaite's Retros., ii., 1866). I can recommend it strongly in painful hæmorrhoids, and also for ordinary external piles.

Cutaneous Disease.—Arsenic is largely used by the profession, almost as a routine remedy, in cutaneous disease, but its value has been variously estimated by specialists of experience. We may exclude at once from its influence parasitic and syphilitic eruptions, and the rarer maladies of scleroderma, keloid, xanthelasma, and true leprosy. We may exclude also all forms of skin

disease whilst in the *acute* stage, or whilst accompanied by marked inflammatory reaction, and then, speaking generally, we may say that as we have noted arsenic to be valuable in rheumatic, malarial, and neurotic affections, so is it also valuable in most cutaneous manifestations of these conditions. With regard to the last-mentioned, my own experience agrees rather with that of Hunt and Anstie, as against Bazin and others, that in neurotic subjects with highly strung excitable natures, arsenic is less readily borne, and more usually causes diarrhœa.

The forms of skin disease in which the remedy is of generally accepted value, are such as psoriasis, eczema in the dry or scaling stage, pemphigus, lichen, alopecia and chronic urticaria.

Psoriasis.—From the time of Girdlestone (1806), Willan and Bateman, Biett and Cazenave, arsenic has held the first place in the treatment of this malady. Modern dermatologists agree upon this point, but some, as the late Mr. Startin and Mr. Hunt, rely upon this drug more positively than others. The preference of Hebra for local over any constitutional treatment is well known, but even he recognises “a decided curative action of arsenic in this form of disease.” Unna, however, will not acknowledge so much as this, and does not prescribe it. Dr. Tilbury Fox was inclined to restrict its use to the more typical cases, especially those of chronic character and accompanied with nervous debility; on the other hand, many cases will be found to occur in persons otherwise strong, and in them after preliminary purgative treatment I have found the remedy useful. Its success, however, is, as Stillé remarks, by no means uniform, and any want of due attention to the excretions, to the presence of gouty or other constitutional tendencies, or to the proper regulation of the dose, will readily prevent a satisfactory result. It can by no means be considered a specific, but as a valuable agent only under certain conditions; neither can it be accurately stated that “the more chronic the malady the more suited it is for this remedy,” for after it has lasted for eight or ten years I have seldom found it amenable, and Devergie has recorded a similar experience (*Maladies de la Peau*).

Mr. Malcolm Morris notes that sometimes arsenic not only does no good in psoriasis, but harm, in rendering the patches more hyperæmic and irritable; he finds it impossible, however, to diagnose the cases in which this may occur (*Pract.*, 1880). I

have seen a case pass on to dermatitis (called lichen ruber) under 15 to 20 min. doses given thrice daily, and improve at once on substitution of pilocarpine, etc.

In judging of its true power, we must allow for the natural improvement of the malady in certain circumstances, *e.g.*, on the cessation of lactation, at changes of climate or of season, etc., also for the effect of external treatment by tar or bathing carried on at the same time. But after these allowances there remain, no doubt, many cases which show distinct improvement from arsenic; the best illustrations are seen in children, and then in older persons in whom the attack is comparatively recent, yet not in an acute stage; chronic cases that have been left untreated often do well, but previous irregular trials diminish the chances of recovery; in any case, if cure be effected, freedom from relapse cannot be guaranteed (Wilson). Hunt has shown how important it is to secure a due action of the absorbents, and also that one preparation may succeed when another has failed; for instance, to one of two girls similarly affected he gave the potash, and to the other the soda solution; for a time both did well, and then both ceased to improve, but later on when he exchanged their medicines, they progressed to cure; he advocated gradually increased doses till some physiological effect was produced. It is of use in psoriasis of the nails.

Eczema.—In this, arsenic has not so large a measure of success as in psoriasis; still it is often very useful, and especially in combination with other remedies. Acute cases not only receive no benefit, but I have seen them much aggravated by it; the proper period for its use requires, therefore, careful consideration. It is very suitable in scaly—which are of necessity rather chronic—stages, and have received the distinct name of “eczema squamosum,” also in superficial subacute forms with moderate infiltration, and in cases with persistent irregular patches about the scrotum, anus, or vulva (Rayer), or about the hands or fingers (Duhring). Sometimes the later stages of a chronic infantile eczema seem much benefited by the addition of the drug to iron or cod-liver oil, and sometimes an infant has been successfully treated by arsenical medication through the mother (Begbie, Anderson). The last-named observer estimates the value of arsenic highly: he points out, as others have done, that children

will readily bear a proportionately large dose; at the same time, he notes that there is much tendency to "catching cold," or even bronchitis, during an arsenical course, also he insists on the necessity for its prolonged continuance. Erasmus Wilson considered that the treatment of eczema resolved itself into that of "debility," and advocated the use of arsenic "as a nerve-tonic and stimulant to cutaneous function". My own use of arsenic in ordinary eczema is rather the exception than the rule, and I am much in accord with Dr. Piffard, who, after calling this mode of treatment "empirical, as opposed to rational," and quoting the prevalent opinion, "that if only sufficient of the remedy be used, the eruption must yield," states that, in his experience, it sometimes does harm and at other times has no influence, though in a minority of cases it will give brilliant results: these may be hoped for in the dry scaly stages when extensive tracts of surface are affected (*On Skin Diseases*, 1870); I would add, and when there are persistent patches on the pudenda or extremities, as already described. It has likewise been used with good results in cheiropompholyx.

Pemphigus.—There is an ephemeral form of this malady in which one or two crops of bullæ come out, and subside under mild general treatment; there is also a syphilitic form mainly congenital, and an epidemic form which occurs sometimes in lying-in and children's hospitals, and is connected probably with blood-poisoning; in none of these do we expect benefit from arsenic. There is a fourth form, occurring sometimes in the later months of pregnancy, which may be severe, and although it tends to subside after parturition, yet may receive some benefit from the remedy; but the variety of the malady to which we would specially refer is that known as "pemphigus diutinus, in which the blebs come out freely, often symmetrically, and extensively,—which often lasts long, and almost invariably exhibits its constitutional origin in a marked tendency to recur." Mr. Hutchinson, from whom I quote, has furnished us with evidence of the great power of arsenic in this variety, although by Hebra and others it is commonly held to be incurable and often fatal, while Mr. Hutchinson "has never met but with one case that resisted this treatment, and has come to consider the malady as one of the most hopeful" (*Med. Times*, ii., 1875). Further experience leads him to state that it will prevent recurrent herpes as well

as pemphigus, but that it does not act so favourably in the aged (B. M. J., i., 1891). He furnishes an abstract of twenty-six cases that have been under his own observation, and refers to others in the practice of Hillier, Wilks, Fagge, Startin, etc.: many of them had relapses, but these were mild in character. In many, the influence of the medicine was proved by the rapid improvement, and by relapse on resumption and omission of it respectively, and in at least one case it appeared to prevent a patient's death. A delicate man aged forty-four, recently become subject to epileptic attacks, presented a general rash, at first very like herpes, and attacking the face and extremities. There was much prostration, and the patient was treated with quinine and iron and liberal diet, yet became extremely emaciated, and as the pemphigus character became more developed, he was covered with large superficial sores and completely prostrated; then the tonics were stopped, and 4 min. of Fowler's solution prescribed, and from that day no fresh blebs appeared until a few weeks later when he was nearly well and able to leave his bed: then it was found that his medicine had been omitted for three days, and on resuming it the blebs at once receded, and six weeks afterwards he was in good health and wholly free from eruption. Dr. James Russell also published a well-marked case in a child in whom the numerous relapses were always distinctly controlled by arsenic. On the other hand must be noted the observations of the late Dr. Tilbury Fox: "There is no specific for pemphigus; arsenic is declared to be one, but it often signally fails to cure the disease, and I have seen quinine in full doses do much more good."

Dermatitis Herpetiformis.—As in pemphigus so in this disease arsenic has sometimes proved to be of value. According to Hutchinson it will, if continued over a sufficiently long period, cure the disease (Arch. Surg., July, 1898). It is recommended that it should be given to full physiological effects and that it should be continued for some time after the disease has disappeared.

In **Lichen Simplex**, and certainly in its more chronic forms, the value of arsenic is generally conceded. Dr. Liveing's expression is, "In chronic lichen it is the only remedy"; but as a rule, alkalies are required in addition, and mercurial treatment may succeed still better. A similar observation would apply to

another form of papular disease—true prurigo, which has sometimes got well under treatment with arsenic together with cod-liver oil and good feeding, when other medicinal agents have failed.

In **Lichen Planus**, Mr. Morris and others speak well of it. Thus a lady aged fifty, with an itching eruption of flat-topped, violet-coloured papules, slightly scaly, situated on the inner side of the thighs and outer sides of the forearms, took 8 min. of liquor sodii arsenatis, at first twice and then three times daily; the eruption faded in one month, and the treatment being continued for a time, no relapse occurred (how long the eruption had lasted is not stated); he considers arsenic “an invaluable remedy.” It is said to be of especial use in the stationary cases, not in the advancing ones, and should be given in gradually increasing doses over a protracted period, from $\frac{1}{16}$ to $\frac{1}{12}$ gr. three times daily. Dr. Fox has, however, seen no benefit from it, nor have I. In the more generalised form of the malady Hebra, who names it “lichen ruber,” places much reliance on the “Tanjore pills” (arsenic with black pepper).

Warts on the hands are said to be cured in three weeks by the use of 2 min. doses thrice daily (Lancet, ii., 1891).

Alopecia.—From the effect of arsenic in improving the coat of horses, it has been plausibly thought to have a special power in promoting the growth of hair, and certainly after any causes of baldness, such as syphilis, dyspepsia, or local irritation, have been treated and removed, the internal administration of small doses may be carefully carried out for a time with advantage. Hunt practised this treatment successfully.

Chronic Urticaria is often relieved by arsenic, but any evident intestinal disorder should, if possible, be remedied in the first instance. In a highly neurotic woman I have seen this malady controlled to some extent by the drug, but she suffered from violent colic after some weeks of treatment; probably she exceeded the prescribed dose.

Acne.—In acne it should be the exception to prescribe arsenic. Sir Erasmus Wilson went so far as to say that “no one having even a rudimentary acquaintance with cutaneous pathology and therapeutics would think of doing so,” and yet I have certainly seen cases cured by this remedy after others had failed. Accord-

ing to Dr. Bulkley, this has occurred with all forms of acne—the simple, the indurated, and the rosaceous—and his best results have been attained with De Valangin's solution of chloride. Dr. Duhring speaks well of it in the indolent papular form, and many special authorities might be quoted to the same effect. This does not seem to me so unreasonable as it does to Sir E. Wilson, for acne is frequently connected with gastric and uterine irritation, and we have seen that arsenic has great power to relieve various forms of these maladies.

In "bromic acne"—the pustular rash which frequently follows the use of full doses of any bromide—arsenic is decidedly useful. If given concurrently with the bromide it will often prevent any skin trouble.

In "bullous" eruptions, especially iodic, it is serviceable—Dr. Bulkley recommends it at frequent intervals (two hours), and in Vichy water (N. Y. Journal, 1889).

Lupus.—There are differences of opinion as to its value in lupus: some esteeming it highly, and recommending its continuous administration for months or years, others, and indeed the majority of observers, record no definite result from it. I have never been able to satisfy myself that it controlled the disease, although the local caustic effect may be, as already mentioned, valuable. Mr. Hutchinson traces recovery in a severe case of lupus erythematosus to the continuous internal use of arsenic for two years.

Herpes Zoster.—Trousseau has observed that the pain in the course of the affected nerves, which is often severe and long persistent in the zoster of elderly persons, may be relieved by arsenical medication, although it will not cut short the course of the attack (Clinical Medicine). In my experience it is less serviceable than quinine. It has proved useful in warding off the recurrence of herpes genitalis.

In **Sycosis**, non-parasitic in character, there is evidence of the value of the drug, and this accords with what we know of it in other cases of the formation of pus. Dr. Laycock used an arsenicated glycerin (2 dr. of Fowler's solution in 10 dr.) as a local application with good results; it is somewhat strong, and acts as a "substitutive irritant" (Med. Times, ii., 1864).

Erysipelatous Inflammation of a phlegmonous type is liable to give rise to sloughing, but if at the first appearance of this

change small doses of arsenic be administered, together with a generous diet, the more severe results may be warded off, and even after sloughing has taken place, arsenic will often control it effectually.

In **Hospital Gangrene** the results obtained strongly incline me to consider it beneficial. In twelve cases in which I have tried it, giving 4 to 10 min. of Fowler's solution every two or four hours, I was well satisfied with the result, especially as arsenic was the only active treatment used; no local caustics were needed. In various other affections of gangrenous character the same remedy has proved very reliable, also in the so-called "cancrum oris" and ulcerations about the tongue.

Epithelioma, etc.—Cases of this disease affecting the lip, the tongue, the scrotum (chimney-sweep's cancer), etc., are stated to have been cured by its internal administration; and although Hirtz concludes that all reports of true cancer being cured by arsenic internally are founded on *mala fides*, or bad diagnosis, yet there is some trustworthy evidence of its relieving cancerous pain in the stomach and in the uterus. Sir C. Locock mentions his own confidence in it, together with cases from his practice, and from that of Brodie and of Sir A. Cooper (Lancet, 1837). Mr. Hunt records a marked instance of relief under small doses frequently repeated, not amounting to more than 10 min. in twenty-four hours. The case was said to be undoubted uterine cancer, and the relief given was greater than from morphine: as a rule a pill was preferred, containing $\frac{1}{20}$ gr. or less of white arsenic. Fordyce-Barker also speaks highly of its power to relieve pain and improve the general condition, in doses of about 3 min. of Fowler's solution (Amer. Journ. Obstet., 1870). I have given this internally in many cases of epithelioma, when the disease was extending rapidly, and have known it apparently retard for a time the progress of the malady, relieve the pain, and improve the general condition. Cases where the lower lip or the scrotum was affected have given me the best results: the dose usually prescribed was 5 min. thrice daily.

Coryza.—Bronchial Catarrh.—Hay Asthma.—In these disorders, in which a profuse secretion is connected with local irritation and with general depression of the nervous system, Fowler's solution is often effectual, especially in patients.

subject to paroxysmal sneezing, with much itching about the *alæ nasi*.

Chronic Bronchitis.—I have witnessed marked improvement under the continued internal arsenical treatment of chronic bronchitis, for which cigarettes and inhalations are sometimes even more suitable than ordinary doses. Bretonneau and Trousseau have recorded good results, and the latter devised a simple cigarette, made with suitable paper soaked in solution of sodium arsenate, or of potassium (1 to 4 gr. in 20 gr. of water for twenty cigarettes). Four or five mouthfuls are inhaled several times daily,—more often when the patient becomes accustomed to it. M. Papillaud recommends, in chronic bronchitis and emphysema, a combination of the drug with antimony (an arsenate of antimony), and considering the relations between these two substances, the recommendation is likely to prove very good (*Gaz. de Paris*, 1865). It is believed by some to be of service in cirrhosis of the lung.

Dyspepsia.—In many cases even of irritative dyspepsia, when the tongue is furred, with red edges and tips, and there is pain after food, heartburn and tendency to diarrhœa, I have had ample experience of the value of Fowler's solution given in 2 or 3 min. doses after meals. Dr. Thorowgood finds that it acts best when the attack seems localised in the stomach, and is independent of "hepatic congestion" (*Pract.*, 1870). Dr. Anstie, whose first published observations were directed to the value of arsenic in gastralgia, previously mentioned to me its equal efficacy in the dyspeptic conditions described.

Vomiting.—Diarrhœa.—In chronic forms of vomiting connected with ordinary dyspepsia, and in that of alcoholism which occurs usually in the early morning and is of a bilious character, with painful straining, arsenic is useful. In the retching and vomiting of pregnancy I have obtained excellent results from 2 to 5 min. doses. Dr. Décamp highly recommended the same treatment (*Philad. Report.*, 1872), and Bartholow mentioned as additional indications for it the rejection of the food streaked with blood, or blood only, with gastralgia and interscapular pain. It is not only serviceable in cases of the rapid passage of half-digested food occurring very soon after meals, but also in cases where the motions are frequent, watery, containing mucus, offensive and irritating to

the anus, and even when bloody and dysenteric in character, and accompanied with tenesmus, prostration and vomiting. In true dysentery, especially when of malarial origin and verging into a chronic state, arsenic is often of the greatest value.

Chronic Gastric Catarrh.—In cases marked by oppression and discomfort after eating, with a sense of weakness and emptiness at the stomach, thirst, offensive breath, coated red-edged tongue, flatulence and pyrosis, with rejection of glairy acid fluid, and general symptoms of depression, coldness of extremities and emaciation, I have had ample experience of the good effect of small doses. In acute gastric catarrh I have not often been disappointed, though a more cautious use is needed, but in the chronic forms, especially when co-existing with emphysema, with chronic bronchitis, or with phthisis, arsenic always gives relief. Many mineral waters that have a reputation in chronic gastric maladies contain an appreciable quantity of arsenic, notably those of Mont Dore, Plombières, and Bussang.

Gastro-enteritis—"English Cholera."—Fowler's solution is an effective medicine in severe cases of this disorder. I have seen it give relief when the patient was suffering from retching and bilious or sanguineous vomiting, passing white, odourless, or slimy flocculent stools, with pain, tympanites and tenesmus; other symptoms present have been—thickly coated tongue, thirst, pyrexia and prostration, muscular cramps, scanty urine, pinched and anxious features. Even when the stage of collapse has commenced; and the surface is dusky and covered with cold perspiration, the medicine has seemed to me of great service—5 min. every one or two hours was the dose given, lessening it as the patient improved.

Cholera Infantum.—This term has been applied to dysenteric diarrhœa in children, probably because of the collapse so readily induced. The child looks pale and thin, and refuses food, the motions are very frequent and brown, offensive and mixed with blood; tenesmus also is commonly present, and often with such symptoms minim doses of Fowler's solution produce excellent results. In the form of the arsenite of copper it has proved particularly useful in various forms of diarrhœa, in cholera morbus, in cholera infantum, in dysentery, and in typhoid.

Gastric Ulcer.—Not only in chronic inflammation, but in

ulceration of the mucous membrane of the stomach, I have seen beneficial results from arsenic, the appetite returning, and the thirst, vomiting and pain subsiding, so that the patients became strong and stout, although before weak and emaciated. Dr. Ringer has observed similar results, and has seen relief from this remedy in chronic ulcer, after failure of the more commonly used medicines. I usually prescribe 1 to 5 min. doses four times daily with a little nourishment.

PREPARATIONS AND DOSE.—*Acidum arseniosum*: dose, $\frac{1}{40}$ to $\frac{1}{15}$ gr. in solution or pill. *Liquor arsenicalis*—Fowler's solution ($4\frac{1}{3}$ gr. in 1 fl. oz.): dose, 2 to 8 min. *Liquor arsenici hydrochloricus* ($4\frac{1}{3}$ gr. in 1 fl. oz.): dose, 2 to 8 min. *Sodii arsenas*: $\frac{1}{40}$ to $\frac{1}{10}$ gr. *Liquor sodii arsenatis* ($4\frac{1}{3}$ gr. in 1 fl. oz.): dose, 2 to 8 min. *Liquor arsenii et hydrargyri iodidi*: dose 5 to 20 min. diluted. *Ferri arsenas*: dose, $\frac{1}{16}$ to $\frac{1}{4}$ gr. *Arsenii iodidum*: dose, $\frac{1}{20}$ to $\frac{1}{5}$ gr. The following are not official. *Liquor arsenii bromidi*: dose, 1 to 5 min. *Cupri arsenis*: $\frac{1}{5000}$ gr. frequently for diarrhœa, etc., during a limited time; $\frac{1}{50}$ gr. for anæmia (Therap. Gaz., 1891, 1892). *Quininæ arsenas*: dose, $\frac{1}{8}$ to $\frac{1}{2}$ gr. *Strychminæ arsenas*: dose, $\frac{1}{100}$ to $\frac{1}{15}$ gr.

Liquor arsenicalis if long kept is liable to vary in strength on account of the deposition of a thin film of metallic arsenic; the compound tincture of lavender contained in it is nauseous to some palates, and it would be better for it to be omitted.

The solution of perchloride is liable to become cloudy in warm weather from the development of a fungus: this may be prevented by the addition of a little perchloride of iron (Hunt).

The liquor sodii arsenatis, as will be found by calculation from its molecular weight, contains only about half as much metallic arsenic as the liquor arsenicalis, and the liquor arsenici hydrochloricus.

In acute or subacute maladies, as of the stomach or intestine, small doses, 1 or 2 min., either every four or six hours, are suitable; in chorea, or neuralgia, or struma, where there is no visceral irritation, the dose may be gradually raised to 5 min. or even more, and in chronic conditions of ague or of cutaneous disease the secret of success will be found in securing the tolerance of a moderate dose for a considerable time.

In malaria it is true that a large dose may be required, and may be well borne during a certain condition of the system, but as soon as that condition is relieved the large dose cannot be tolerated.

In skin diseases large doses are never desirable, and any in-

crease beyond 4 or 5 min. should take place only after this dose has been used for three or four weeks without physiological symptoms. This remark refers especially to the potash and to the acid solutions, not to that of the arsenate of sodium, for although nominally of the same strength, the last-mentioned contains less arsenic, and is often better borne in doses of 6 to 8 min., or more, than the others in less quantities. The remedy, sufficiently diluted, should always be given in several such moderate quantities daily, rather than in one full dose, and always at a meal or with some food, so as to lessen the degree of local irritation; the symptoms of its physiological action, such as irritation of the conjunctivæ, œdema, nausea, etc., should be constantly watched for, and the dose diminished rather than entirely omitted if the reason for its administration remains. In some obstinate cases, especially of chorea and of skin disease, it is justifiable and not harmful to keep up a moderate degree of physiological action for some time, but this must be done very cautiously.

It is a matter of daily experience that the secretions must be in good order if we are to expect the full advantage of the remedy in chronic disease. Mr. Hunt observes: "Above all, the bowels must not be allowed to act sluggishly. In many cases a full dose of calomel and compound colocynth pill will be required two or three times a week, and these doses are sometimes essential to the cure. If the legs, or feet, or abdomen become œdematous, and the urine scanty, the case will not go on well till we have roused the kidneys to vigorous action by full doses of spiritus ætheris nitrosi and acetate of potassium, etc." (Journ. Cutan. Med., v., ii.).

The administration and the powers of arsenic in combination with other remedies require special consideration. We have already noted that it enhances the value of iron, for instance in amenorrhœa, anæmia, struma, eczema, etc.; there is a good effervescing citrate of arsenic and iron, which I have often found serviceable. Iodide of arsenic has been esteemed by some practitioners on the Continent and in Ireland, especially by Neligan: as much as from $\frac{1}{10}$ to $\frac{1}{4}$ gr. in pill thrice daily has been given. The same physician employed also an ioduretted solution, containing 5 min. of Fowler's solution, 1 gr. of iodide of potassium, and $\frac{1}{4}$ gr. iodine in 1 dr. of orange syrup; it is rather agreeable,

keeps well and has given good results, and has seemed preferable to Donovan's solution (Dub. Journ., vols. xvi., xxii.).

CACODYLIC ACID AND ITS COMPOUNDS.

For the last year or two much attention has been given to the organic compounds of arsenic known as cacodylates.

Girardin, and later Chapuis, had previously shown that oils and fats were to some extent antidotal to the poison, and that if arsenious acid were thoroughly mixed with butter, larger doses could be tolerated, an organic compound being formed (*Influence des corps gras*, etc., 1880). Cacodylic acid, also an organic arsenical compound (discovered by Bunsen in 1840), is obtained by the oxidation and hydration of an arsenic radical, Cacodyl— $\text{As}_2(\text{CH}_3)_4$ —which is a colourless liquid fuming in air, and results from the dry distillation of arsenious acid with acetate of soda.

Cacodylic acid occurs in white crystals, free from odour, of slightly acid taste, soluble in water and alcohol, insoluble in ether: it contains 54·35 per cent. of arsenic, one part being equal to 0·715 part of arsenious acid: it has the formula $\text{AsO}_1\text{OH}_1(\text{CH}_3)_2$ as compared with arsenic acid, $\text{AsO}(\text{OH})_3$, two of the hydroxyl groups (HO) being replaced by two of methyl (CH_3), which change is sufficient to modify most of the characteristics of the metallic compound: the ordinary reactions of arsenic salts do not occur, and the toxic properties are much lessened. Cacodylic acid is not readily oxidised, but when “reduced,” changes into cacodyl and its oxide, which are highly toxic, and have a repulsive alliaceous odour. Bunsen demonstrated that cacodylic acid was less poisonous than ordinary forms of arsenic when he injected over 5 gr. of it into the ear vein of a rabbit without producing serious symptoms, and Rabuteau confirmed this experience in other animals—a dog was not killed until the dose was increased to 22 gr.

Sodium cacodylate is a crystalline soluble non-irritant salt, and is therefore a convenient form for administration. Ferrous cacodylate has been prepared, and is a green powder soluble in cold water, but oxidising rapidly to the ferric salt, which is brown and amorphous—these preparations are not constant in their proportions and a special form is prepared by Clin under the name of Marsyle. What is claimed for the cacodylate compounds is that

they are more readily assimilated and tolerated than the metallic forms, and in larger doses, but when administered by the mouth they are sometimes "reduced" in the stomach, giving a garlic odour to the breath and secretions. Hence they have been advised in enema, and preferably by hypodermic injection, in which manner doses of $\frac{5}{8}$ or 1 gr. are commonly given, whilst 4 to 6 and even 12 gr. of the acid have been administered daily for several weeks by Dr. Danlos (June, 1899). Dalché (Soc. Méd. Hôp. Fer., 1900) and also Galliard gave the soda salt in doses of $\frac{3}{4}$ to 3 gr. daily with but temporary dyspepsia in some cases, but on the other hand with $\frac{1}{2}$ gr. doses I have seen severe gastric and other symptoms.

It has been suggested that the preparation used was not pure, and it is very important to make sure on this point. I have used the sodium salt extensively, but never give more than $\frac{1}{16}$ gr. three times daily, and have had good success in neurasthenia, tuberculosis, diabetes, anæmia, and in fact in all cases in which arsenic was indicated. Remarkable cases of cure of tuberculosis and diabetes have been recorded by Renant (Bullet. Acad. Méd., May, 1899) and of the former by Gautier (*ib.*, June) and others; of dermatoses by Danlos, and of chorea by Garand (Loire Medical, 1900). Gilbert and Lereboullet recommended the iron salt (Ref. de Pharm., 1900).

R. Maguire has used the sodium salt in phthisis, and speaks well of it as a "body stimulant," not as a cure (Lectures, B. M. J., ii., 1900), but my friend Dr. Johnston Lavis giving it to eight cases found improvement in all but one, which was of general diffusion after influenza: in one old-standing case of neurasthenia the "effect was marvellous," and in another very favourable after failure of other treatments. He gave always a daily dose of 5 centig. of the sodium salt either by the skin or the rectum. Dr. Mackey using the same dose by the skin or rather more by the mouth has obtained markedly good results in some seven cases of chorea, and Lannois has reported very favourably of the effects of rather smaller doses (B. M. J., i., 1901, Epit.).

Murrell records a case of a young woman suffering from phthisis who was ordered a grain of cacodylate of sodium in pill three times a day. After taking eleven doses she suddenly developed symptoms of acute poisoning, including nausea, vomiting, neuritis and paralysis of the extensors of one wrist (B. M. J., ii., 1900). The balance

of later experience makes it on the whole probable that, as Sir Thomas Fraser has maintained, these preparations are no more effective and are perhaps less safe than Fowler's solution.

AURUM—GOLD, Au = 196.6 (19570).

This "king of metals," as it was formerly termed, is found native in the "veins" of rocks, and as gold-dust or nuggets in the sands of certain plains and rivers; it is separated by washing, or by means of mercury, which is afterwards driven off by heat; it occurs also in alloy with silver, copper and iron, but not as an oxide, nor in any other than the metallic form.

COMPOUNDS OF GOLD.

AURI PERCHLORIDUM—PERCHLORIDE OF GOLD—"POTABLE GOLD" OF ALCHEMISTS ($\text{AuCl}_3 = 303$) (*not off.*).

This salt is used in photography and in analytical chemistry, and a solution of it, freed from excess of acid, is used as a test solution for atropine.

AURI BROMIDUM (*not off.*).

The tri-bromide of gold is a brown powder soluble in water.

AURI ET SODII CHLORIDUM—CHLORIDE OF GOLD AND SODIUM (U.S., *not off.*).

CHARACTERS.—An orange-yellow crystalline powder, deliquescent, soluble in water, less so in alcohol.

ABSORPTION AND ELIMINATION.—Salts of gold are readily decomposed by organic substances and coagulate albumin, but when the soluble chlorides are given internally they become absorbed to some extent (probably in the intestine (duodenum, Dixon)) as oxides combined with albumin. When rubbed upon the gums and tongue, according to an old-fashioned method of administration, they are also absorbed, but are liable to cause much local irritation. Neither metallic gold nor the oxides can be absorbed

(although poisoning by gold leaf is said to be an aristocratic method of suicide in China), nor is an ointment containing either these or the chlorides likely to produce any effect through the skin.

Elimination occurs through the liver and intestinal canal, especially the lower bowel, but is very slow (Husemann); the fæces are coloured dark brown by a combination with sulphur. After large doses some passes in the urine, which is coloured yellow during the process. Rabuteau maintains that the elimination of gold is never complete, some of the metal being reduced and deposited, especially in the epithelial and nerve tissues; for on examining these parts in the body of a rat that had died after taking 15 gr. of gold chloride in fourteen days, he found the contour of the epithelial from the intestinal tract to be very strongly marked, as by nitrate of silver, and the axis-cylinder of the nerve tubules to be coloured slightly green; he considers that this deposition of the metal explains why gold seems more active than mercury, for having nearly the same atomic weight and specific heat, their properties should (according to the analogies of other substances as observed by him) be also very similar, were it not that the gold is less completely eliminated: but though mercury may, as a rule, be more readily eliminated than gold, yet it has also often been found deposited in the bone, the liver and other parts of the body long after its administration.

PHYSIOLOGICAL ACTION.—*External.*—The chloride of gold has an irritant caustic effect, and stains the skin a yellow colour, which becomes violet and later black, from reduction of the metal.

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—Small doses increase appetite and digestive power, and stimulate the secreting organs, but under larger or continued doses this stimulation readily passes into irritation, and there are often dryness of the tongue, redness of the pharynx, and some gastric irritation, with nausea, colic and diarrhoea (Cullerier); on the other hand, though the intestinal secretions are increased, constipation has been noticed by several observers. Nutrition is so far modified that emaciation results from prolonged administration.

Glandular System.—Salivation has been commonly described as a result of this medicine, and is said to occur after a longer period,

and with less marked stomatitis than when produced by mercury. (True salivation is denied by some observers who describe only gingivitis.) Martini met with ptyalism only after the long-continued use of small doses, and found that the double chloride of gold and sodium might be taken for many months without injurious effect; only in one case did ptyalism occur, and then $\frac{1}{8}$ of an oz. had been taken (Schmidt's Jahrb., 1870). The secretion of the sweat-glands is increased, especially during the night, and this alternates with or accompanies an increase in the quantity of urine (Gozzi, 1817). The stimulation of the glandular system and of growth is said to be such that adenitis has followed the use of gold, and tumours of osseous or of glandular character have become painful and inflamed (Percy, Rapport à l'Académie). Some excitement of the genital organs occurs, so that in men priapism may be caused, and in women the catamenia increased (Legrand, De l'Or): active vascular dilatation of the testes has been described after even small doses. A similar effect on the kidney induces diuresis some hours after administration, and it is said to last longer than after caffeine.

Nervous System.—The central nervous system and the intellectual powers are said to be stimulated by gold somewhat in the same manner as by alcohol. Large doses cause paralysis in frogs, and this appears to affect the optic lobes and cerebellum first, then the spinal cord, and, lastly, the cerebral hemispheres.

Circulatory System.—According to Dr. W. E. Dixon, small doses quicken the heart action and slightly lower blood pressure, large doses lower it considerably—acting through the vagi. The effect is dependent largely on active vaso-dilatation in the abdominal viscera, especially of the kidneys.

Respiratory System.—Large doses injected into the veins cause œdema of the lungs, and death from asphyxia; there is also a catarrhal condition of the respiratory passages produced.

Toxic Effects.—A peculiar febrile condition—"auric fever"—including headache and many of the above-mentioned symptoms as sweating and diuresis, may supervene if a course of the remedy be continued for two to four weeks, and seems to be analogous to mercurial fever (Niel, Recherches, Paris, 1820). In animals, general emaciation and convulsive twitchings have preceded death, and besides the evidence of metallic deposition in the tissues,

Rabuteau records a yellow coloration of the gastro-intestinal mucous membrane. Large doses of gold compounds may certainly cause gastritis and death, with cramp and other severe nervous symptoms (Majendie), and asphyxia.

Stevenson has recorded (in *Guy's Hosp. Rep.*, vol. 50) the case of a boy who took about 12 grains of terchloride of gold, and became immediately sick (with black vomit) and collapsed, with cold extremities. Purplish black staining was noticed about the lips, mouth and hands. He was thirsty and complained of pain and tenderness over the epigastrium, and the abdomen was retracted. Thin watery motions were passed, brown in colour, containing mucus, no blood, respiration normal. Urine normal and contained no gold, but traces were found in the vomit and fæces. The boy recovered without further symptoms.

SYNERGISTS.—Mercurials.

ANTAGONISTS.—INCOMPATIBLES.—Albumin in any form,—milk, flour, etc.

THERAPEUTICAL ACTION.—*External*.—As a caustic the chloride has been used by Landolfi and Recamier in lupus and in carcinoma. Legrand employed it in ulceration of the neck of the uterus, and also as a lotion and a vaginal injection. Mechanically, gold leaf is employed by dentists for stopping teeth, and by druggists for coating pills.

THERAPEUTICAL ACTION.—*Internal*.—In former times, when fanciful analogies of colour or of accidental qualities largely determined opinion as to the medicinal value of any substance, gold was praised as a remedy for melancholy and for the dyspepsia often connected with it, and after several centuries of disuse, confidence in its therapeutical power has been, to some extent, revived mainly by a few French and Italian physicians. The double chloride of gold and sodium is the preparation most recommended.

Syphilis.—M. Chrestien of Montpellier, and later M. Legrand, have recorded many cases of both primary and secondary syphilis cured under the influence of gold, and Trousseau observes that such results are now well proven and incontestable. Chancres and condylomata have got well under this remedy in a manner not likely to be due to nature, and in my own experience its efficacy has been still better seen in the later tertiary developments,

such as ulceration in the nose and larynx, cutaneous syphilides, hard nodes, etc.; as much as 10 grains daily has been given. It is said to cure without local applications, but often an "unguentum auri" has been used in addition. Gold may especially be employed in long-standing cases with chronic periostitis, and when mercury has been already given to saturation.

Dietrich, whilst denying to gold any true anti-syphilitic power, thought it most valuable for mercurial cachexia (*Journal des Connaissances Méd.-Chir.*, 1840), but this has not been corroborated by many observers. Auric fever may occur during a course of the remedy, and for a time the general health may suffer and the local manifestations may be more irritable, but on lessening the dose the pyrexia subsides, and good effects are more conspicuous.

Tuberculosis.—Advocates of the medicinal use of gold—especially Niel and Legrand—have spoken strongly of its value in tuberculous disease of the bones, in glandular enlargements, "white swelling," goitre and even elephantiasis, but Velpeau and others have not corroborated their statements in hospital practice. No doubt, as Trousseau remarks, the treatment of tuberculosis amongst the poor really requires more than any drug can effect, and it would be unfair to discredit gold altogether because it has not cured some hospital patients. I think myself that it may prove a useful adjunct, or at least a good alternative treatment. Majendie and Roux have reported some illustrations of its value, and Mr. Chatterley has recorded a case of extensive indolent scrofulous ulcer affecting the right foot, unrelieved by iodide of iron, etc., but cured by small doses of the gold chloride (*Lancet*, ii., 1852); also another case of cure of a cachectic child suffering from enlarged and indurated cervical glands (*Med. Times*, i., 1854); he recommended $\frac{1}{24}$ gr. mixed with orris-root to be rubbed on the tongue for one to five minutes daily. A case of hypertrophy of the tongue with induration, which was probably syphilitic or tuberculous in character, was cured by the use of 1·5 gr. internally, and local frictions with 1 gr. mixed with lard (*Amer. Med. Journ.*, vol. xix.). It is probable that the so-called cures of *cancer* by gold have really been of tuberculous ulceration.

Uterine Disorders.—Nöggerath refers to the value of this medicine in amenorrhœa and in chronic ovaritis, and says it is

suitable for cases of the former dependent upon torpor; it should not be given during pregnancy, nor to persons liable to undue flooding. Martini states that it is serviceable in cases with a tendency to abortion, in chronic metritis, and in cases with mental symptoms of hysterical character, especially when these are connected with definite uterine disorder. A compound of gold with arsenic, mercury and bromine is recommended in menorrhagia and a variety of female disorders, as well as in anæmia and malnutrition (especially in childhood) (N. Y. Med. Journ., 1899).

Chronic Bright's Disease, etc.—Dr. Bartholow draws special attention to the value of salts of gold in the treatment of granular and fibroid disease of the kidney and “depurative disease.” He has observed remarkable improvement from the persistent use of small doses of the chlorides— $\frac{1}{30}$ to $\frac{1}{20}$ gr., three times daily; they are not suitable for acute stages of the disease. The cure of two cases of *diabetes* under the chloride of gold and sodium was reported in the Edin. Journ. for Oct., 1891. In liver cirrhosis, in locomotor ataxy and other forms of sclerosis, gold salts have been of late recommended, especially in the combination mentioned above.

Dyspepsia, etc.—Dr. Bartholow is also one of the most decided of modern writers in recommending small doses ($\frac{1}{20}$ gr.) of the double chloride for “nervous dyspepsia,” as “indicated by a red glazed tongue, epigastric pain increased after food, and tendency to relaxation of the bowels: also in duodenal and biliary catarrh and jaundice.” Vertigo and vertiginous sensations connected with stomach disorder are often relieved by small doses of gold chlorides, but plethora and increased intracranial blood-pressure contra-indicate their use. On the other hand, they do good in cerebral anæmia, so that they may be prescribed when bromides would not be suitable. Melancholia and hypochondriasis with depression are often connected with gastric disorder and with cerebral anæmia, and are susceptible, to some extent, of relief by the same remedy (*cf.* B. M. J., ii., 1891).

It is said to be serviceable in chronic alcoholism, but (as already remarked of phthisis) has not yet received professional trial or assent (B. M. J., ii., 1892) (see under Preparations). In *epilepsy* and *hysteria* the bromide of gold in $\frac{1}{5}$ to $\frac{1}{2}$ gr. doses has been useful (Lancet, i., 1890), and is said to be more effective, better tolerated and less depressing than other bromides. It would seem also to con-

trol better the convulsions produced in animals by electric stimulation of the cortex cerebri, especially when injected into the veins.

As compared with other bromides it was calculated to be more active in the proportion of 5 to 1. (Dixon in H. White's Text-book.)

Hemi-Anæsthesia.—I must not omit to notice a modern application of gold as a remedy, in its metallic form in "metallotherapy," as developed mainly in Paris by Prof. Charcot and others some years ago. It seems that rather a large proportion of nervous patients on the Continent suffer from impaired sensation of one-half of the body of a functional nature, and that by the application of two metals, as a gold and a copper coin over several nerve trunks, sensation may be "transferred," returning to the affected side in about a quarter of an hour, but often leaving at the same time the previously sound side. Such a peculiar circumstance is not yet wholly explained, but has been ascribed to a galvanic action (Med. Record, 1878-79). The late Dr. A. Hughes Bennett and others explained the phenomena rather by "expectant attention," and I believe that mental influences of various kinds are a much more likely explanation than any specific properties of metals thus applied. Since the last edition of this work very little has been heard of this method.

PREPARATIONS AND DOSE.—There are none official, but the double chloride is in the French, German and U.S. Pharms. The *pulvis auri* was formerly used in pill ($\frac{1}{4}$ to $\frac{1}{2}$ gr.), or in syrup (24 gr. to the ounce), or in ointment (30 gr. to the ounce) for frictions, especially on the tongue. The cyanide has also been used in the same manner, but none of these can be recommended. *Auri et sodii chloridum*, $\frac{1}{30}$, $\frac{1}{15}$ or $\frac{1}{2}$ gr. in pill. *Auri bromidum*, $\frac{1}{30}$, $\frac{1}{15}$ or $\frac{1}{2}$ gr. *Auri et potassii bromidum* (more soluble), $\frac{1}{6}$ to $\frac{2}{3}$ gr. If given by the skin, as advised, a special needle not liable to oxidation must be used, such as gold or platinum. All gold salts readily decompose and must be kept from air and light. The compounds *liqr. auri brom. arsenatis* and *liqr. auri brom. hydrarg. arsenatis* (Arthur, Damancy and others) are more stable, 10 min. contain $\frac{1}{32}$ gr. of each ingredient.

In the Lancet of 1892 may be found many particulars of the so-called Keeley gold cure for alcoholism, for which publication he threatened an action for libel, which was withdrawn. In a note referring to his death it is stated that most of the cases so treated relapsed (Lancet, i., 1900, and ii., 1902. No gold was found on analysis of Keeley's remedy). The Hagey system for the treatment of inebriety by gold perchloride proved injurious in New Zealand (*ib.*, i., 1899). Not gold but pilocarpine is said by some to be the

active agent in the hypodermic injection (B. M. J., ii., 1898); but a formula given by Dunham is Sod. et Auri chlorid., $\frac{1}{24}$, with Strych., $\frac{1}{60}$; Nitroglycerin, $\frac{1}{300}$; Atropin, $\frac{1}{200}$; Digitalin, $\frac{1}{60}$ (Quart. Journ. Inebr., Oct., 1895).

For snake bite Calmette injected a 1 per cent. solution of auric chloride (Lancet, ii., 1899).

BARIUM, Ba = 137 (136.40).

This is not met with native, but abundantly as the base of an alkaline earth called *baryta* or *barytes* (an oxide), which occurs extensively as native sulphate (BaSO_4 , heavy spar), and carbonate (witherite). The metal itself has not yet been obtained in a coherent state, but only as a powder.

BARYTA ($\text{BaO} = 153$) (*not off.*, but in U.S.P.).

CHARACTERS AND TESTS.—A greyish-white earthy-looking substance, heavy, sp. gr. 5.4, of sharp caustic taste and strongly alkaline reaction; sprinkled with water it becomes hot, and slakes with energetic action, falling into a fine white powder, hydrate of barium ($\text{Ba}(\text{HO})_2$), which contains eight molecules of water of crystallisation, and is soluble in 10 parts of boiling water.

BARI CHLORIDUM—CHLORIDE OF BARIUM

($\text{BaCl}_2, 2\text{H}_2\text{O} = 244$).

It is placed in the appendix as a test for sulphuric acid.

CHARACTERS AND TESTS.—It occurs in translucent soluble crystals, which have a bitter acrid taste; they contain two molecules of water of crystallisation. The solution gives with any soluble sulphate a heavy white precipitate of barium sulphate, not soluble in nitric acid.

Carbonate of Barium is a white insoluble powder: *Barium Sulphide* is also a white powder, but is soluble in water: it is luminous in the dark.

ABSORPTION AND ELIMINATION.—Orfila detected the chloride of barium in the liver, spleen, and kidneys of animals poisoned by it (Annales d'Hygiène, ii., 1842). Neumann has made numerous observations on this subject, and after injecting *sulphate* of baryta into the veins of animals, he searched for it in the urine and also in the blood some hours afterwards,

but without detecting it: it was, however, found deposited in the liver, spleen, kidney, and bone. When the *chloride* of barium was given in the same manner, the greater part passed by the bowel, but some was found in the urine and saliva, as well as deposited in bone. He concluded that the drug was not easily eliminated (Rev. des Sci. Méd., 1886).

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—Small doses ($\frac{1}{2}$ to $\frac{1}{4}$ gr.) of the chloride exert a stimulant effect on the stomach, increase the appetite, and often produce loose stools. Larger doses prove irritant or caustic; 3 gr. taken several times daily soon induce a sense of pressure at the epigastrium, nausea, vomiting and purging, with faintness (Fergusson, Dub. Journ., 1844). Dr. Shoemaker refers to a death from $2\frac{1}{2}$ gr. taken in daily doses of $\frac{1}{4}$ gr., but this must be very exceptional; the minimum fatal dose is commonly put at 1 dr., which has caused much vomiting and purging, and death in convulsions in seventeen hours (Walsh, Lancet, 1859). Two and a half dr. were given to a girl by mistake for Carlsbad salt, and caused vomiting in twenty minutes, and death in four and a half hours (B. M. J., i., 1892). Half an ounce caused similar irritant symptoms, and death in two hours—evidence of severe gastrointestinal inflammation was found (Taylor). The nitrate and acetate of barium have also caused death, and the carbonate is commonly used as a poison for rats and mice. Although one teaspoonful has destroyed life, much larger doses have been taken without fatal results.

Since strontium salts have been more used in medicine, the amount of barium commonly contained in them has become an important consideration; it has been estimated recently as not more than 1 in 1,000, which should be well under an injurious dose.

Nervous System.—The nervous symptoms caused by toxic doses of barium compounds are clonic convulsions and motor paralysis, with impairment of reflex excitability: Binet adds fibrillary contraction and muscular cramps (Rev. Méd. Génér., 1892). From the slow respiration observed in cases of poisoning, it has been concluded that the vagi become paralysed (Walsh). According to Cyon, the lesion is central, for even in advanced poisoning the muscular irritability and the sensibility of peri-

pheral nerves remain intact (Reichert's Archiv, 1866). Severe pains in the head, throbbing in the temples, giddiness, dimness of sight, double vision, deafness and tinnitus, have been experienced: also muscular cramp, especially in the legs.

Circulatory System.—The heart's action is at first stimulated, afterwards quickly and powerfully depressed by full doses of barium compounds. After some palpitation, the pulse becomes irregular, feeble, or imperceptible, and the surface cold and pale. Blake found that small doses ($\frac{1}{4}$ gr.) raised blood-pressure, while larger doses caused a transient rise succeeded by a fall, or from the first a sudden fall according to the dose given: he also observed that voluntary muscles were apparently stimulated and twitched for a long time after death (Edin. Med. Journ., 1841). Boehm concludes that the action is very similar to that of digitalis (Archiv expt. Path., iii.). Onsum suggested that barium compounds caused embolism by precipitation of the sulphates of the blood (Virchow's Archiv., Bd. xxviii.), but Cyon has shown both that the normal sulphates exist in very small amount, and that even if they are artificially increased, no precipitate occurs on giving baryta.

Dr. Ringer has pointed out the great similarity of the effect of barium compounds and digitalis on the frog's heart: the pulse is slowed, and the heart finally stops in systole; the blood-pressure is raised, probably from the direct action of the metal on the muscular tissue of the vessels; these actions take place independently of the nervous system (B. M. J., i., 1883). In a circulating fluid, small quantities of strontium or barium salts will replace calcium salts with which they are chemically analogous. Strontium accelerates the beats of the heart more than calcium (Pract., ii., 1883).

Glandular System.—We have no clear evidence of the effect of baryta on the lymphatic system, but it is presumed to exert some absorptive "deobstruent" power on inflamed or hardened lymphatic glands. Small doses increase the secretion of urine and of perspiration.

SYNERGISTS.—Lime and other alkaline earths. The chloride of barium has some analogies with corrosive sublimate.

INCOMPATIBLES.—All sulphates are chemically incompatible with barium salts, forming insoluble compounds. The

sulphates of sodium and magnesium have been used as antidotes in cases of poisoning (Walsh), also white of egg and sugared wine (Perondi, *Bull. de Thérap.*, t. x.).

THERAPEUTICAL ACTION.—*External.*—**Depilation.**—Dr. McCall Anderson recommends the sulphide of barium for removing superfluous hair, one part of it being made into a paste with four parts of zinc oxide and a little water; this should be left on the part for about three minutes, and then washed off; it should be prepared only as required for use and may be made stronger, 1 to 2 or 3, with a little starch added and may be left on longer (five to ten minutes).

THERAPEUTICAL ACTION.—*Internal.*—**Tuberculosis, etc.**—Barium chloride was introduced at the end of last century as effective in scrofulous and syphilitic dyscrasiæ, in gonorrhœa, white swelling, etc. (Crawford, 1780). Lisfranc and Torget used it in such cases and in glandular tumours, and reported much advantage from it; the former began with $\frac{1}{8}$ gr. every hour, and increased the dose to much larger quantities than we should consider safe (40 gr.). In a child, many glandular tumours subsided under a month's treatment, but frictions with potassium of iodide were used at the same time (*Amer. Journ.*, 1838; *Bull. de Thérap.*, 1840). Mr. R. Phillips recommended barium chloride as superior to iodine in many cases marked by pallor, languid circulation, and irritable mucous membranes (*On Scrofula*, 1846), and Mr. Balman used it in chlorotic and cachectic states generally (*Med. Times*, ii., 1851). In amenorrhœa he gave $\frac{1}{2}$ to 1 gr. doses with perchloride of iron. Many cases of successful treatment of scrofulous joint disease, of ophthalmia, and of enlarged glands by barium chloride ($\frac{1}{12}$ gr. doses) were recorded some years ago (Ranking, 1846). Dr. B. Thorne reports cases of glandular disease, of anæmia and of cardiac dilatation benefited by Llangammarch water, and Dr. George remarks on the constant association of barium with calcium chloride (*Lancet*, ii., 1894).

Cardiac Disease.—Barium chloride has also been used to a limited extent in valvular heart disease as a substitute for digitalis. Da Costa praises it highly in restoring compensation and lessening cardiac pain; he gave $\frac{1}{10}$ gr. in pill three or four times daily, for about three weeks. Larger doses may be given, but in his opinion tend to cause diarrhœa (*Amer. Journ. Med. Sc.*, 1888).

Dr. A. H. Hare finds that it slows and steadies the heart, that it acts as rapidly as digitalis, and does not disorder the stomach; small doses, $\frac{1}{2}$ to 1 dr. of a 1 per cent. solution, did good in mitral incompetence and acute dilatation (Pract., 1889). Dr. J. S. Carpenter agrees as to its value but advises caution, for a patient aged thirty-one, having taken $1\frac{1}{2}$ gr. three times, was attacked with symptoms of gastro-enteritis and collapse: he recommends as a dose $\frac{1}{2}$ dr. of a 1 per cent. solution gradually increased to 2 dr. (*ib.*, 1891). The waters of Llangammarch contain $6\frac{1}{2}$ gr. per gallon of barium chloride, and are ordered in cases of palpitation, etc. (Lancet i., 1897, etc.).

Aneurism.—Dr. F. Flint considering that it gives tone to the vascular wall, used it in a case of fusiform aneurism of the abdominal aorta in doses of $\frac{1}{5}$ gr. thrice daily; within a fortnight improvement ensued, and in five months cure was complete. Prolonged rest and rigid dietetic treatment were used at the same time (Pract., 1879).

Epilepsy, etc.—Hufeland introduced this remedy for epilepsy in scrofulous subjects, but it is now seldom used. Brown-Séquard, however, whilst reporting against its efficacy, remarks that it may diminish reflex excitability, and therefore deserves trial, *e.g.*, in tetanus and in paralysis agitans. In satyriasis, or excessive sexual desire, it has also been employed.

PREPARATIONS AND DOSE.—*Barium chloridum*: the dose mentioned by Dr. Garrod and others is from $\frac{1}{2}$ to 2 gr., but Mr. Kennedy, after much experience, maintains that $\frac{1}{16}$ to $\frac{1}{12}$ gr. is much more suitable and safer to commence with; very few persons, he says, can bear $\frac{1}{8}$ gr. without irritation (Lancet, ii., 1873). Dr. Thursfield mentions a spring near Shrewsbury with 16 gr. in the gallon, and at various collieries amounts from 9 to 96 gr. per gallon may be found.

BISMUTHUM—BISMUTH, $\text{Bi} = 210$ (207·30).

Bismuth occurs native, and also as an oxide, a sulphide, and variously combined in metallic ores with silver, iron, copper, arsenic, tellurium, etc.

CHARACTERS.—This element is grey-coloured with a roseate tinge, and may be obtained in masses of cubical, iridescent crystals; it is tasteless and inodorous, heavy (sp. gr. 9·83), hard, brittle, and, like antimony, volatilises at a high temperature.

COMPOUNDS OF BISMUTH.

BISMUTHI OXIDUM—OXIDE OR SESQUIOXIDE OF BISMUTH
($\text{Bi}_2\text{O}_3 = 468$).

CHARACTERS.—A smooth, yellowish powder, insoluble in water, more definite in composition, and more constantly pure than other bismuth compounds.

Bismuthum Peptonatum. Peptonised bismuth is a brown powder containing $3\frac{1}{2}$ per cent. of oxide (not official).

The Oxychloride of Bismuth (not official) is prepared by adding an acid solution of the trichloride to water, or by mixing a solution of nitrate with one of common salt. It should be an impalpable, neutral, non-irritant, white, insoluble powder, and is known as "pearl-white."

The oxy-iodides of bismuth (not official) are either yellow or darkish-red amorphous powders, insoluble and free from taste or smell: the yellow is the milder, containing less iodine.

BISMUTHI SUBNITRAS—SUBNITRATE OR OXYNITRATE OF
BISMUTH—WHITE BISMUTH—SPANISH WHITE
($\text{BiONO}_3, \text{H}_2\text{O} = 306$).

CHARACTERS.—The subnitrate is crystalline, but when well prepared should be in smooth and fine powder. It is heavy, white in colour, and becomes yellowish-grey on exposure to light from the formation of some sulphide, or from the presence of silver; it is insoluble in water, soluble in nitric acid. A solution of bismuth subnitrate and sodium hydrate in water and glycerin is the Löwe test for sugar in urine: it has the advantage of being stable.

BISMUTHI SALICYLAS—SALICYLATE OR OXY-SALICYLATE
OF BISMUTH ($\text{C}_6\text{H}_4\cdot\text{OH}\cdot\text{COO}\cdot\text{BiO}, = 363$).

CHARACTERS AND TESTS.—Prepared by mixing bismuth nitrate and sodium salicylate, it is a heavy, whitish, amorphous powder, in-

soluble in water, alcohol and glycerin; reacting to tests for the metal (see below) and giving a violet colour with ferric chloride.

The salicylate of bismuth and cerium is a double salt of similar character.

*LIQUOR BISMUTHI ET AMMONII CITRATIS—SOLUTION OF
CITRATE OF BISMUTH AND AMMONIUM—LIQUOR
BISMUTHI.*

CHARACTERS AND TESTS.—A colourless liquid, of saline metallic taste, sp. gr. 1.07, miscible with water. Liquor potassæ precipitates the white hydrate, and hydrochloric acid the white oxychloride, but an excess of acid re-dissolves this as chloride. The official solution is neutral, or slightly alkaline.

BISMUTHI CARBONAS—CARBONATE OF BISMUTH
 $((\text{Bi}_2\text{O}_2\text{CO}_3)_2, \text{H}_2\text{O} = 1042).$

CHARACTERS AND TESTS.—The salt is precipitated as a hydrated oxycarbonate, which, like the subnitrate, is insoluble in water, but is more soluble in the gastric juice, and has antacid properties.

On passing a current of sulphuretted hydrogen through an acid solution of a bismuth salt, the black sulphide of bismuth (Bi_2S_3) will be thrown down. Concentrated acid solutions of bismuth salts poured into water give a white precipitate of a basic salt, *e.g.*, the nitrate when thus treated yields the subnitrate. Caustic alkali added to a solution of a bismuth salt precipitates the white hydrate of bismuth ($\text{Bi}_2\text{O}_3 \cdot \text{H}_2\text{O}$). Papers saturated with sulphocyanide of potassium are coloured yellow by soluble bismuth salts (*cf.* p. 562).

ABSORPTION AND ELIMINATION.—Bismuth in substance is not absorbed by the skin, and the supposed instances of poisonous effects from its use as a cosmetic are not trustworthy (Husemann). A soluble bismuth salt, such as the ammonio-citrate, is, however, quickly absorbed from the cellular tissue after hypodermic injection. From wounds, also, bismuth has sometimes been absorbed so largely as to cause toxic effects.

Cases of bismuth poisoning from the local application of the oxyiodogallate (airol) have been recorded by Aemmer and Stäger. Aemmer points out that although airol is insoluble in ordinary solutions yet it is soluble in glycerin, and that this "emulsion" produces toxic effects. Poisoning by the local use of the subgallate (dermatol) is described by Wiesner (*Therap. Monatsch.*, 1895). Steinfeld, injecting a soluble salt of bismuth into the skin and the circulation, found it excreted fairly rapidly by the kidney

(L. M. Record, 1886), and Hans Meyer corroborates this to some extent, but finds that the presence of sulphuretted hydrogen readily precipitates bismuth as a sulphide on the mucous surface of the intestine (Lancet, i., 1886).

Much difference exists in the degree of absorption of bismuth-compounds taken by the mouth, and the difference is proportionate to their solubility. The acetate, the double tartrate, and the ammonio-citrate dissolve in the gastric fluids, and are readily absorbed, whilst the oxide and subcarbonate are but slightly soluble, and the ordinary subnitrate still less so.

Headland taught that it was as insoluble as charcoal, but Orfila and Lewald have detected the drug in the liver, the milk, and the urine, after its administration, though in the last secretion it appeared later than other metallic salts. Bergeret and Mayençon detected it in the same fluids and in dropsical exudations, and after giving small doses to rabbits they found it, within half an hour, in the blood, the spleen, the muscles, etc., and continued to find traces of it for eight days after administration. In one man they also found it five days after; in another, testing sixty-two days afterwards, they did not find any (Journ. de l'Anatomie, 1873). We may conclude, therefore, that some amount of absorption even of the subnitrate occurs (probably as chloride), although the greater part of what has been taken has been found unchanged in the stomach in some cases, or converted more or less into the black sulphide in the intestinal canal, or has been eliminated with the fæces during life. It may accumulate in the intestinal canal and sometimes prove serious, as in the case of a woman who died from cancer, and in whom a large agglutinated mass of bismuth salts was found distending the stomach; she had taken no bismuth for two months before death (Pract., i., 1882). It is probable that more absorption occurs with small doses (such as the grain or less used originally by Odier, of Geneva) than with the very large ones (several hundred grains daily) prescribed by Monneret.

PHYSIOLOGICAL ACTION.—*External.*—The pulverulent bismuth compounds have an absorbent and protective effect: they are also astringent and sedative. The crystallised nitrate, especially when dissolved in glycerin, is astringent, but may be

irritating, even somewhat caustic. Dr. H. Wood recommends the oxy-iodides as excellent antiseptic absorbent remedies in emulsion, powder, or ointment, for use like iodoform, and in similar cases; they seem to be mild, fairly stable preparations of *iodine*, which, however, they readily give off when in contact with organic bodies (B. M. J., i., 1889). The salicylate has also marked antiseptic power, and the subgallate (dermatol) is said to be astringent without being irritant; but that is not my experience, with regard to mucous membranes at least.

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System, etc.**—Bismuth salts taken in the form of powder exert upon the gastric mucous membrane a sedative, slightly astringent effect, similar to that already described as their external action. Taken in a liquid form, the effects are still of the same kind, but produced by smaller doses and with more tendency to irritation. Whether pure bismuth salts, when taken internally, can exert an irritant poisonous action, or are in the largest doses practically innocuous, has been much disputed. Orfila and Meyer, in experiments on animals, found that both the nitrate and the subnitrate, in doses of 1 to 2 dr., caused vomiting, tremor, depression, and death, with *post-mortem* evidence of gastro-enteritis (Toxicologie, ii., and Wibmer, Wirkungen, etc.). Hägler has produced symptoms of bismuth poisoning in guinea-pigs by the administration of the oxyiodogallate. Kerner records the case of a man who took 40 gr. of the subnitrate, and suffered from gastric oppression and burning pain, thirst, griping, bilious vomiting and relaxation, with vertigo and headache; and another of a man who swallowed 2 dr. (mixed with cream of tartar), and died after violent symptoms of irritant poisoning, such as burning pain in the throat, purging, vomiting, cramps and paralysis: after death, inflammation and gangrene were found in the alimentary tract. Sobernheim subjoins to these cases one that after a 2 dr. dose proved fatal in nine days, with similar symptoms, including also delirium and general swelling; inflammation and gangrene of the stomach and intestines were found (Arzneimittellehre). Trousseau alludes to a similar case recorded by Pott in 1739, and Dr. Traill reports one where vomiting and pain followed the taking of 6 dr. (in divided doses). Christison describes “bismuth, in its saline combinations, as an active

poison," and Taylor quotes some of the above cases as "proving that a substance very slightly soluble in water may exert a powerfully poisonous action on the human system."

On the other side we must place the strong evidence of Trousseau and Monneret, and the daily experience of a majority of practitioners. Trousseau states that during a very extensive use of well-prepared subnitrate in doses of from 15 to 60 gr., he has never seen the slightest accident, or had the least cause for apprehension (*Mat. Med.*, i.), whilst Monneret prescribed the enormous doses of 150 up to 900 gr. per diem, without any inconvenience resulting. He noted only slight constipation with lessened odour and blackened colour of the fæces; there was no thirst, nausea or pain, and the appetite was rather increased than diminished. Such doses as the above are not likely to be now prescribed, but many physicians order 20, 30 or 60 gr. several times daily without any evil result.

The toxic symptoms above noted have been attributed to the presence of *arsenic* as an impurity, and in some cases correctly, as shown by Taylor. H. C. Wood also records a case of bloody purging from the use of an adulterated drug, and the effects are certainly those of an irritant poison. Still, as a rule, there is no evidence of the presence of arsenic sufficient to produce serious results, even in the most adulterated specimens of bismuth. Stillé speaks of $\frac{1}{6}$ per cent. as the maximum proportion found, whilst Parral and Garnier ascertained that preparations containing 0.129 per cent. did not poison dogs, even in doses of 200 to 500 gr. Monneret suggested that in the above cases either a previous illness became suddenly exaggerated, or an excess of *soluble nitrate* acted as an irritant: the last alternative seems possible after recent evidence that soluble compounds of bismuth have an activity hitherto not supposed to exist in pure preparations. The acetate (according to Bricka), the double tartrate (Rabuteau), and the ammonio-citrate (Stephanowitsch), given in large doses, produce poisonous symptoms very like those of the allied metals, gold and quicksilver. Rabuteau "at first held the classical opinion as to the remarkable harmlessness of bismuth," but his observations with the double tartrate or "emetic" of bismuth and potassium ($C_4H_4K(BiO)O_6$) have convinced him that *slight solubility* explains the general absence of dynamic effects after large doses of

the ordinary preparations. The tartrate is soluble in water without decomposition, and has a metallic taste like that of ordinary "tartar emetic"; it causes vomiting, and 30 to 60 gr. prove fatal to small dogs. In connection with this observation, it is noteworthy that in Kerner's fatal case, the patient took cream of tartar with his dose of bismuth, and the salt referred to by Rabuteau would probably be formed. Stephanowitsch records of the ammonio-citrate that its hypodermic injection, in the proportion of 1 gramme to each 1,000 grammes of body-weight, will kill animals, and that salivation and buccal abscess follow its use, as well as fatty degeneration of the liver, kidneys and heart. The glycogen of the liver disappears under its prolonged administration (Lebedeff). G  rard has made some important observations on the possibility of slow poisoning from the ingestion of the subnitrate in some pathological states of the stomach. He states that the insoluble preparations are not innocuous in conditions of dyspepsia with fermentation leading to the production of lactic and butyric acids. This is due, he believes, to the incomplete precipitation of the subnitrate as oxychloride by the chloride of sodium of the gastric juice. He made experiments in dogs, giving the subnitrate with lactic acid, and obtained a slow poisoning, the principal symptom of which was an interstitial nephritis (Compt. Rend. Soc. de Biol., Paris, 1897, 10th ser., iv.).

Although some of the older cases were connected with the presence of arsenic, bismuth cannot be held innocuous as regards either the digestive or the nervous system, and its activity depends upon its solubility: there is probably also some idiosyncrasy as to the drug. The oxide, carbonate, and subnitrate, though but slightly soluble, may be taken up to some extent, especially when small doses are used. Odier, of Geneva, gave only a few grains, or less than a grain, and noticed occasionally vomiting, diarrhoea, a sense of heat, vertigo, and drowsiness. M. Guersant has noted colic and "sense of anxiety," and Rabuteau some general sedation, like the effect of antimony, and I have observed some clinical evidence in the same direction; but the existence of a chronic form of bismuth poisoning, marked by an  mia, swelling of the gums, and h  morrhage, as described by Lusanna in man, and by Stephanowitsch in animals, cannot be ignored. Feder-Meyer describes an acute form marked by increased pulse and respiration rate,

diarrhœa, muscular spasm, and death from asphyxia with extravasation of blood into various organs, also a chronic form accompanied with fatty degeneration (Abst. Lancet, i., 1883). Maxsen has noticed cyanosis in children from bismuth poisoning (Ann. Gynecol. and Pediat., Boston, 1896-7). Steinfeld verified a systemic action on the medulla oblongata, shown by early excitement and after-depression of all the functions of the nervous system, resembling the effect of picrotoxin and also of barium in several respects (Internat. Journ. Med. Sci., i., 1886). In several of the surgical cases treated locally by bismuth there is a record of the supervention of a general scorbutic state as described by Lusanna and especially stomatitis and gingivitis (Rev. Gén. des Sc. Méd., 1884-86). Instances have been recorded by Kosher, Petersen, Dalché, and four cases recently by Gaucher and Balli. The principal symptoms have been a dark coloration of the urine which contains albumin and epithelial casts, gingivitis, stomatitis, salivation, black coloration of the gums, and slate-coloured plaques on the buccal mucous membranes; occasionally a false membrane on the palate and fauces, and diarrhœa with vomiting (Soc. Méd. des Hôp. de Paris, 1895). In connection with this may be mentioned Dr. Brinton's statement that the subnitrate taken continuously will cause a bluish-red line on the gums "similar to, but wider and more red than, that known to be caused by lead" (Dis. Stom.). There is, however, little, if any, experience of toxic effects from bismuth in English medical literature.

The action of *Liquor Bismuthi et Ammonii Citratis* differs from that of the solid compounds, and probably represents the real activity of the drug, independently of the mechanical effect of a powder; it is more irritant, and has sometimes failed to relieve gastric pain when the subnitrate has succeeded. The carbonate is less liable to irritate than the subnitrate, and yet it is more soluble in the gastric juice; it does not perhaps absorb intestinal gases so readily as the subnitrate or oxide, but has better antacid powers, and is not so likely to constipate. Hannon traced to it also some primary sedative effects, like those described by Rabuteau of the nitrate, *viz.*, weakening and slowing of the pulse, lessened appetite, and increased excretion of urine, but found that its continued use improved strength and vigour like iron preparations.

The oxychloride seems a still better local mechanical sedative, and is more soluble. Some antiseptic action shown by the nitrate depends upon the acid with which it is combined, and which will give an acid reaction to several washings of water (Binz). The suboxide will, like arsenic, absorb oxygen from damp air and so may act as an oxygen carrier in the intestine.

SYNERGISTS.—Mechanical absorbents, antacids, and sedatives. Magnesia is specially suited for combination with bismuth salts.

INCOMPATIBLES.—Acids are incompatible with the subnitrate of bismuth (Gubler), and some have advised the omission of all acids from the diet during its administration. Practically, however, their effect is only to favour the production of the more soluble nitrate, which should, in suitable doses, act favourably without discomfort, and a few minims of nitric acid are not infrequently prescribed with it; they should be omitted, however, if a merely protective effect is desired from an insoluble preparation. Alkaline carbonates are decomposed by it with effervescence. Bismuth prescribed with a strong solution of iodide of potassium is precipitated as a red iodide, which is insoluble and inactive, (B. M. J., ii., 1870), unless as an antiseptic.

THERAPEUTICAL ACTION. — *External.* — **Erythema, Eczema, etc.**—In these and allied forms of congestive and inflammatory skin disease, bismuth compounds are extremely useful, by virtue of their absorbent, astringent and soothing properties. In erythema and erysipelas, intertrigo and bedsore, they may be applied in powder, alone or diluted with starch or magnesia, or made into a cream with water and glycerin, or into an ointment in the proportion of 30 to 120 gr. in the ounce of prepared lard, cold cream or vaseline. (Dr. McCall Anderson, in praising this ointment, notes that it should not be made with *benzoated* lard, or else, for some unexplained reason, it becomes liable to irritate.) An oleate of bismuth is a good preparation, and forms an excellent dusting powder; according to Dr. Louis Lewis oleic acid may be made to take up 20 per cent. of oxide of bismuth (Pharm. Journ., Dec., 1876).

In subacute stages of eczema and in burns, when there is much irritability and much serous discharge, these preparations are also serviceable; they seem to be sufficiently astringent, yet not so

much so as lead, zinc, or tannin, and will often act better than those remedies. A 10 per cent. ointment of the subgallate with vaseline is said to be good; a stronger one is liable to irritate. In later stages, when there is infiltration with redness and scaliness, a stronger solution of the soluble nitrate becomes suitable. The oxyiodogallate (airol) has been found useful as an unirritating antiseptic application (dusting powder or ointment with lard or lanoline) for ulcers, whitlows, boils, etc.

In the erythema connected with acne of the face, bismuth is good either as oleate or as an ingredient in soothing lotions: a small quantity of corrosive sublimate (2 gr. to 8 or 10 oz. of liquid) is often combined with great advantage, when sulphur and other stimulants could not be borne.

As a cosmetic under the name of "blanc de perle," bismuth salts have long been celebrated: they are liable to become darkened by contact with sulphur (*e.g.*, the sulphuretted hydrogen of ordinary gas, etc.), some proportion of the black sulphide being generated.

For chaps and fissures about the hands, lips, nipples, etc., bismuth ointment is very good, and especially with a little tincture of benzoin (20 to 30 min. to 1 oz.). Trousseau specially commends it for anal fissure, and others for ulceration of the septum nasi, and excoriations of the cervix uteri. Follin used a glycerole, containing 1 or 2 parts in 3 of the liquid, for chronic granular conjunctivitis.

Catarrh.—Chronic Discharges.—Monneret recommended the insufflation of bismuth powders for coryza, and in chronic catarrhal conditions Soubrier used a snuff containing 4 parts of the subnitrate with 8 of liquorice and 30 of iodide of sulphur. For acute cases Dr. Ferrier reintroduced a formula containing $\frac{1}{2}$ to 1 gr. of morphine, well triturated with 60 gr. each of the subnitrate and of gum acacia, and this often acts well in cutting short a troublesome "cold in the head"; I have frequently prescribed it, but have found patients complain of its causing frontal headache and clogging of the nostrils. In leucorrhœa, bismuth has been applied in powder or paste, on charpie, or as injection in the proportion of 1 to 8 of water, and has been used with advantage in gonorrhœa and gleet (Caby). One part of the oxy-iodide in 100 parts of water has been recommended as an injection in gonorrhœa.

The subnitrate has been found useful in soft chancre—but after bathing with perchloride solution—and it acted sometimes well as an astringent and germicide (Med. Record, 1884-85). It is well spoken of in bromidrosis (B. M. J., i., 1886).

Wounds, etc.—Many observations have been made on the Continent as to the use of bismuth for wounds, and after surgical operations. Rocher reported cases healing well under 1 per cent. of bismuth subnitrate suspended by trituration with water, and he was corroborated to some extent, but when large quantities were used in substance, some toxic symptoms appeared (Amer. Journ. Med. Sci., 1883). The general conclusion now is unfavourable to this mode of treatment as compared with that by more active antiseptics.

THERAPEUTICAL ACTION.—*Internal.* — **Dyspepsia.**—According to Monneret, “pain arising during digestion, from whatever cause,” may be relieved by mixing the subnitrate freely with the food, but more definite indications may be given. Gastric pains dependent on indigestible food, marked constipation or hepatic congestion, require emesis or purgation, whilst in vomiting connected with fermentation of food, dilatation of stomach, gastric catarrh, etc., antiseptic remedies (*e.g.*, salicylate of bismuth, Lancet, ii., 1886) and washing out of the viscus may be necessary.

Bismuth is indicated in cases of difficult digestion with tendency to diarrhœa, in subacute or chronic gastritis from alcohol or other cause, and in gastralgia with marked irritability of the gastric mucous membrane: for such cases, Odier first introduced it (in Geneva, 1786); he describes severe gastric pain as frequent amongst the servants there who lift and carry on their heads large vessels of water—the pain was either spasmodic, sudden, intense and relieved by pressure, or more persistent and accompanied with sensations of gnawing, sinking and pulsation; eructation, nausea and vomiting occurred in greater or less degree, and the general health and mental state became much depressed. Such cases were much relieved by bismuth in moderate doses: and Marcet, Bardsley, and other English physicians have published similar experiences.

Nothnagel finds it useful when pain occurs after food in badly nourished, over-worked persons; but when there is marked

anæmia or a general neuralgic condition it is not so serviceable alone, nor is it permanent in its good effects. Prussic acid, or opium, alkalies, and later iron and bitters may be conjoined with it. Caizergues especially praises a combination of 4 gr. with $\frac{1}{2}$ gr. of extract of belladonna in the gastralgia of chlorosis (Lond. Journ. Med. Sci., 1851).

When *acid pyrosis* is a marked symptom, bismuth is indicated either alone or combined with magnesia, especially if constipation be usual. According to Trousseau, if the rejected fluid be insipid, glairy, or sour ropy phlegm, bismuth *alone* is contra-indicated, but in most cases it deserves trial, requiring only that constipation be remedied. The nausea and vomiting of gastric irritation is commonly amenable to bismuth, *reflex* vomiting, such as that of pregnancy, not so (Husemann), which is an argument in favour of the local protective effect of the drug; the oxychloride has some advantages in these cases.

In *infantile vomiting*, which is frequently dependent on acidity or ill-digested food, and accompanied by diarrhoea and pain, bismuth is exceedingly useful, being, as it is, practically harmless and tasteless—1 to 2 gr. may be placed on the infant's tongue with a moistened finger. A minute dose of creasote, $\frac{1}{16}$ of a drop, may often be usefully combined with it (B. M. J., ii., 1875). A special indication for the use of bismuth in the dyspepsia of children is said to be a tongue either clean, or slightly coated, but with redness and enlargement of the papillæ fungiformes at its base; besides this will be found the ordinary symptoms of pain after food and nausea (Dunbar, Pract., v., ii., 1882).

In **Ulceration of the Stomach**, when pain is very severe and vomiting frequent, much relief may be given by full doses; I have noticed that distressing thirst has been relieved rather than increased by the remedy. Dr. Brinton attached great value to it; it is often given with opium in such cases, and the oxyiodide has been recommended.

In **Malignant Disease**, also, I have found bismuth palliate for a time the most severe symptoms; and in both these conditions it acts mainly by forming a smooth layer over exposed and hyper-sensitive nerves, and so preventing the contact of food and unhealthy secretions: to obtain such a result it is evident that more than the ordinary dose is required.

Diarrhœa.—In irritative diarrhœa, with red tongue, nausea, heartburn, griping pain worse after meals, and frequent ill-formed stools, I have found bismuth invaluable. In some persons, mostly women, such a condition becomes habitual, and even ordinary articles of diet may cause severe aggravation of symptoms; the constant use of this remedy, however, gives them the greatest relief, and enables them to take food with comparative comfort; much flatulence is often present, and sometimes the diarrhœa depends on irritation from the development of sulphuretted hydrogen (Chambers). Bismuth is then also very suitable, for it combines readily with that gas and absorbs it (Pract., 1869); sometimes charcoal, or aromatic chalk powder, or rhubarb, may be added with advantage, or the salicylate may be found preferable. The compounds of bismuth with beta-naphthol, phenol, tribromophenol and tetra-iodophenol-phthalein have been recommended as agents that produce intestinal antiseptis without any toxic symptoms (Wilcox, Med. News, N.Y., 1897).

The salicylate, pyrogallol and bromophenol compounds and the sulphite also control fermentation in the intestine without interfering with the digestive processes. The sulphite has been used as an anthelmintic.

Infantile Diarrhœa.—When infants at the breast suffer from eructations, sour vomiting, diarrhœa, light-coloured papescent stools of bad odour, with crampy pains in the stomach, I have always found bismuth act well. In that form of diarrhœa which so readily affects children whilst being weaned, or during hot weather, or in that which continues even after irritation has been removed, it is also of great service; from 1 to 5 gr. may be given several times daily to children of one year and under. Weller prescribed for children as much as 30 to 60 gr. of subnitrate every hour (interdicting milk during the treatment), with no other than good results (Amer. Journ., 1870).

The *ulcerative diarrhœa* and aphthous condition connected with phthisis is alleviated by full doses. Traube (one of the first to recommend the remedy in such cases) supports the view of its acting mainly as a mechanical protective, lessening local irritation, and consequently reflex peristalsis. The powder is sometimes found to line the whole tract, and it is evident that for such protective effect large doses are necessary. Dr. T. Thompson, who

prescribed about 5 gr. of the subnitrate with magnesia and mucilage, and Monneret, who gave many drachms for a dose, are strong advocates of its advantages. The latter observer states that he had seen many persons who were apparently dying with tuberculous diarrhœa restored for a time to comparative health (Med.-Chir. Trans., v., 31), but the results obtained by others have not been so favourable. The persistent diarrhœa of enteric fever is sometimes well treated in the same manner, and in this also the salicylate is a good preparation.

Dysentery.—M. Brassac, of the French naval service, records the best results from bismuth in epidemic dysentery. Finding little or no benefit from small doses, he followed the teaching of Monneret, and beginning with 230 to 300 gr. daily, increased to more than 1,000 gr.; he divided this into about five doses according to the case, giving it in broth or milk, or sometimes by enema, and so long as more than one stool occurred in the day. This plan was very successful and had no ill result; as a rule, his patients began at once to eat better and to gain strength (Edin. Med. Journ., 1867). Trousseau also used bismuth injections in dysentery (Lancet, i., 1855), and Dr. Houghton wrote from Borneo concerning their great value in subacute and chronic cases in tropical climates; he prescribes 30 gr. with mucilage to be injected two or three times daily, and retained if possible (Lancet, ii., 1879). In acute and chronic colitis, Lasèque also used with the best results enemata of 30 to 150 gr. with egg or mucilage.

Cholera.—In the epidemic at Warsaw, in 1831, it was highly approved by Leo, and in later epidemics at Paris it was commended by Trousseau, and very largely used for the premonitory diarrhœa; at the commencement only of the attack a little opium may be added with advantage; afterwards, two full doses of bismuth daily will suffice. The tribromophenol compound of bismuth with an equal quantity of the oxide (xeroform) in doses of 5 to 20 gr. has been especially recommended for this disease.

PREPARATIONS AND DOSE.—*Bismuthi oxidum*: dose, 5 to 20 gr. *Bismuthi subnitratis*: 5 to 20 gr. or more (see below). *Trochiscus bismuthi compositus*: dose, 1 to 6 lozenges (each lozenge contains 2 gr. with lime and magnesia). *Liquor bismuthi et ammonii citratis*: dose, $\frac{1}{2}$ to 1 fl. dr. and upwards (contains about 3 gr. of oxide in each fl. dr.). The preparation of Schacht is said to contain only 1 gr. of oxide to each dr.: dose, 1 to

4 dr. *Bismuthi carbonas*: dose, 5 to 20 gr. or more. Of the oxychloride, and salicylate, and the double salicylate with cerium the dose is from 5 to 20 gr.; of the oxy-iodide, from 5 to 10 gr.; of the peptonised bismuth, $\frac{1}{2}$ to $1\frac{1}{2}$ fl. dr.; of the subgallate, 30 gr., this is a yellow insoluble powder (dermatol) and is used more in ointment (*v. p.* 553); of the naphthol and phenol compounds, 10 to 30 gr.; of pyrogallol bismuth, 2 to 3 gr.; of sulphite, 5 to 30 gr.

Preparations of bismuth should be taken about a quarter of an hour before or with meals, and if a mechanical protective effect is most desired, acids are better avoided during the medication.

Subnitrate.—The dose should depend upon its molecular state. Thus, if it be very dry and likely to become caked together in the stomach, very large doses may not act at all, or may cause irritation, whilst if moistened or formed into hydrate or carefully mixed with some other fine powder, moderate doses will give a much better result. Quesneville took 80 grammes without much advantage, but afterwards using the drug thoroughly soaked in water soon obtained good effects with 5 to 10 grammes; his "*bismuth-cream*" is a valuable preparation better known abroad than in this country. The subnitrate forms a part of the "*poudre de Wendt*," also of the powder of Robert Thomas; combined with magnesia it is "*Patterson's or American powder*," and with pepsin, the "*poudre de Royer*." The *liquor bismuthi et ammonii citratis* is miscible with water and spirit, but not with alkalies without precipitation. The so-called "*lac bismuthi*" contains the hydrate mechanically suspended, dose, $\mathfrak{z}\text{i}$. A *lactate*, a *tannate*, and a *valerianate* of bismuth have been described: the first is a soluble salt, and may be given in small doses; the compound with tannin, like that with gallic acid, is designed to favour its astringent, and the valerianate its nerve-tonic powers. A citrate of iron and bismuth is sometimes useful.

A glycerole of the neutral nitrate is best prepared by dissolving $\frac{1}{2}$ oz. of the crystallised salt in 2 dr. of pure glycerin and an equal quantity of distilled water, afterwards adding glycerin to 6 oz.

ADULTERATIONS.—Besides being variable in its chemical constitution, in the amount of oxide and of acid present, the *subnitrate* may contain added carbonate and phosphate of lime, carbonate of lead, subchloride of bismuth, and other metals introduced in the process of manufacture, also certain natural impurities not removed, *e.g.*, traces of iron, copper, silver and arsenic: the last is the most important. In the older preparations it was probably always present, and so long ago as 1743 Geoffrey expressed his fear of bad results from it (*Materia Medica*). In later times, Dr. Taylor found it in three out of five specimens; and Mr. Ekin found it in many specimens of *liquor bismuthi* when it was first introduced (*Pharm. Journ.*, 1868).

The practical bearing of such adulteration was illustrated in a

trial for arsenical poisoning at Philadelphia. It was proved that bismuth "nitrate" had been prescribed shortly before death; a specimen of the particular salt dispensed could not be found, but of ten others purchased in the city a majority contained arsenic, and although the irritant symptoms had commenced before bismuth was prescribed, and the proportion of arsenic found in the viscera was much more than bismuth adulteration would account for, yet the trial was stopped, and the accused person discharged (Amer. Med. Journ., 1858). At the present time, however, adulteration with arsenic is exceptional. Of six chance specimens examined under the direction of Dr. Anstie not one contained it (Pract., 1871); and Prof. Siebold, after much experience, reports that it is now rarely found (Pharm. Journ., 1875). Of seven samples of the basic nitrate of the American codex, one only contained arsenic. In the oxide he often found traces of sodium and lead, and commonly subchloride and subnitrate.

Selenium and *tellurium* have been found in some specimens of bismuth salts, and a Colorado ore of the metal has been found to contain 34 per cent. of tellurium. This would explain the offensive alliaceous odour which is sometimes given to the breath by special samples of bismuth preparations. In 1824, Gmelin noticed the peculiar odour of the breath caused by taking tellurium. Hansen found that in a few minutes after the first dose the garlic odour was perceptible, and it became so strong that he had to exclude himself from society: the odour persisted for eight days after the last dose (Liebig's Annalen, 1853). Reissert took 5 milligrms. of tellurous oxide (TiO_2) three times in one day. Fifteen minutes after the first dose the breath had a strong garlic odour, and in one hour a metallic taste was observed; the urine, sweat and fæces had the same odour. The metallic taste lasted 72 hours, the odour in the urine lasted 382 hours, in the sweat 452 hours, and in the fæces 79 days, and in the breath 237 days. He calculates that $\frac{1}{166600}$ gr. tellurium is enough to impart the peculiar odour to the breath (Pharm. Journ., May, 1884). Sir James Simpson also made trial of the drug, and Sir Douglas Maclagan relates that on one occasion a student took a dose which obliged him to sit apart from the class for the rest of a session (Edin. Med. Journ., 1854). Further confirmatory evidence is given by Ekin. The nature of the odorous compound is not known (Pharm. Journ., 1875).

Hansen thinks it must be a volatile organic substance formed in the body.

The *carbonate* of bismuth is liable to contain chlorides, also sodium, and sometimes lead. In five specimens examined by Prescott no arsenic was found (Pharm. Journ.). The Pharmacopœia directs that bismuth and its preparations should yield no evidence of arsenic by Marsh's test; no blue coloration with ammonia, showing the absence of copper; no precipitate on filtering and saturating the ammoniacal filtrate with nitric acid, showing the absence of tin and cadmium; no red or black precipitate with sulphite of sodium, showing the absence of selenium and tellurium; and no blue precipitate with ferro-cyanide of potassium, showing the absence of iron.

CADMIUM, Cd = 112.

This is a somewhat rare metal, found associated with zinc in nearly all its ores, and obtained from these by distillation.

CADMII IODIDUM—IODIDE OF CADMIUM ($\text{CdI}_2 = 366$).

Cadmium iodide and solutions of the same are in the Appendix of the B.P.

CHARACTERS.—Occurs in flat, micaceous white crystals, of pearly lustre, which melt at 600°F. into an amber-coloured fluid; they are anhydrous, permanent in air but decompose at a dull-red heat, with evolution of iodine in vapour. In water and spirit they are freely soluble, the solution being acid to test-paper.

The Sulphate of Cadmium is official in the U.S.P. It occurs in oblique rhombic prisms, translucent and colourless like those of zinc sulphate; it has an acid, astringent taste, effloresces on exposure, and dissolves readily in water.

The Bromide of Cadmium resembles the analogous salt of ammonium, and has been taken by mistake for it; it is used in photography.

ABSORPTION AND ELIMINATION.—Cadmium salts coagulate and combine with albumin, but these albuminates.

dissolve in an excess of the salt, especially in excess of a double salt, such as the chloride of cadmium and sodium; even in alkaline chlorides they are partially soluble, so that we can readily understand their absorption from the stomach. Absorption occurs also after their injection into the cellular tissue, the bowel, etc., as evidenced by the finding of cadmium compounds in the organs and secretions (Marmé, Schmidt's Jahrb., iii., 1867).

Elimination of the drug begins soon after its administration, and takes place mainly by the kidneys.

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—Cadmium compounds, except the sulphide, resemble each other in action. The sulphide, though considered poisonous by Van Hasselt, has been given to animals in drachm doses daily for a week without evident effect, and is therefore pronounced inert by Marmé. The oxide, chloride, sulphate, iodide, etc., given in doses of $\frac{1}{2}$ to 2 gr., cause pain at the epigastrium, vomiting and purging, and in somewhat larger doses gastro-enteritis, which may pass on to ulceration. Similar effects follow their hypodermic injection, and after toxic doses given in this manner, the gastrointestinal mucous membrane has been found inflamed; irritation and suppuration also occur at the site of injection. The continued administration of small doses induces a chronic form of poisoning marked by dyspepsia and emaciation, which in animals has terminated in death from exhaustion. In the case of two women who took by accident a quantity of bromide of cadmium (not less than 5 or more than 16 gr.) a pungent taste and sensations in the mouth and throat were felt, and burning pain at the epigastrium, vomiting and purging set in and continued for five hours, and after recovery the stomach remained very irritable (Boston Med. Surg. Journ., 1876). In a man who took 9 gr. of a cadmium salt, salivation, colic and catharsis followed in the course of an hour, and four hours afterwards violent vomiting, gastralgia, and tenesmus (Burdach). In a dog, death has followed the injection of $\frac{1}{6}$ to $\frac{1}{3}$ gr. into a vein, or the giving of 5 to 9 gr. by the mouth.

Nervous and Circulatory Systems.—Foret has described in cases of poisoning by cadmium carbonate, besides the symptoms of gastric irritation—giddiness, prostration, loss of consciousness, cramp, and slowing of the heart and of respiration. In the women

above mentioned, somnolence was marked after subsidence of the irritant symptoms.

SYNERGISTS.—Salts of zinc and lead.

ANTIDOTES.—In acute poisoning by cadmium salts, the alkaline carbonates with albumin (white of egg) are the best antidotes. In Marmé's experiments, injections of dilute soda solutions into the stomach soon after the exhibition of the poison quite prevented bad effects.

THERAPEUTICAL ACTION.—*External.*—The iodide is used in the form of ointment in glandular affections, and has been recommended by Guibert and Garrod; other physicians have prescribed it in splenic enlargement and in strumous skin disease (Waring). I have used it repeatedly in cases of enlarged glands, nodes, and chronic joint-inflammation, with satisfactory results. It does not stain the skin, like iodide of lead, but is liable to cause irritation unless diluted. The oleate of cadmium is said to be a good form, and to act well as a local gland-stimulant.

In **Ophthalmic Surgery** cadmium sulphate has been used as an astringent in the form of lotion or ointment for inflammation of the eye, and for corneal opacities (V. Gräfe, Middlemore).

THERAPEUTICAL ACTION.—*Internal.*—The sulphate of cadmium has been recommended in syphilis, rheumatism and gout (Grimaud), but there is, at present, little evidence of its special powers.

PREPARATIONS AND DOSE.—*Unguentum cadmii iodidi* (*not official*) (contains 62 gr. in 1 oz. of simple ointment). *Cadmii sulphas* (*not official*): dose, $\frac{1}{12}$ to $\frac{1}{2}$ gr.; for *collyrium*, $\frac{1}{2}$ to 4 gr. in 1 oz. of rose-water (Fronmüller); for *ointment*, 4 gr. in 1 oz. of lard; for *injection*, 2 gr. in 1 oz. of water; these formulæ seem inconsistent with Bouchardat's statement that the salt is ten times as powerful as the sulphate of zinc.

CALCIUM—LIME, Ca = 40 (39·71). (*Not official.*)

Calcium is a greyish-white metal: as a carbonate it occurs naturally in chalk, marble, etc.; as a sulphate in gypsum; as phosphate and carbonate in shells, bones, and various organic tissues; and as silicate and fluoride in various minerals and

vegetables. When heated, it becomes quickly oxidised and converted into *lime*—*calx*: when set fire to, it burns with a bright light.

CALX—LIME—CALCIUM OXIDE—QUICK-LIME ($\text{CaO} = 56$).

CHARACTERS AND TESTS.—A greyish-white solid, of specific gravity 3.18, and of alkaline, caustic taste. When water is poured on it to the amount of about three-fourths of its weight, it swells up, evolving great heat (up to 500° F.), and falls into a soft, white powder, in which the oxide is combined with one molecule of water (hydrate of calcium); the process is called “slaking”.

CALCII HYDRAS—CALCIUM HYDROXIDE—SLAKED LIME
($\text{Ca}(\text{HO})_2 = 74$).

CHARACTERS AND TESTS.—The hydrate of lime, a strongly alkaline white powder, though it can absorb 31 per cent. of its weight of water, remains perfectly *dry*, and is itself very sparingly soluble in water (1 part in 730 of cold, but only in 1,300 of boiling water): at 32° F. twice as much lime is dissolved as at 212° F. At ordinary temperatures water dissolves only about $\frac{1}{2}$ gr. to the ounce, but its solvent power is increased by sugar or by glycerin to the extent of nearly 8 gr. to the ounce. Lime does not melt at the highest temperature, and hence its use for the electric and oxyhydrogen lights. It is also employed in making *ext. ipecac. liq.* Its specific gravity is 2.078.

The chief test for lime is the white precipitate formed with oxalate of ammonium, insoluble in acetic acid, but soluble in hydrochloric or nitric acid. Lime readily absorbs carbonic acid, the presence of which is detected by effervescence with other acids.

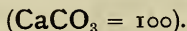
The Liquor or Aqua Calcis of the Pharmacopœia is a solution in water containing about $\frac{1}{2}$ gr. of hydrate of lime to the ounce (that being its point of saturation). It is prepared by digesting slaked lime in eighty times its weight of cold water for some hours, and is a colourless liquid when recently made, but on exposure to air, or if breathed into, an insoluble carbonate readily forms and is precipitated. If warmed, the liquor calcis becomes turbid from deposition of some of the lime. It forms an ingredient in the black and the yellow “mercurial wash”.

Liquor Calcis Saccharatus.—Saccharated lime-water is prepared by mixing slaked lime with twice its weight of sugar, and digesting in water for a few hours; it becomes yellowish by keeping; its taste is more caustic and unpleasant than that of

the simple liquor; it contains 7.11 gr. of lime per ounce in the form of saccharosate.

Linimentum Calcis is an emulsion or soap formed with equal parts of lime-water and olive oil.

CALCII CARBONAS—CALCIUM CARBONATE

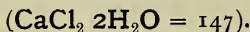


Two forms are official: (1) *Creta præparata*—prepared chalk—the native, friable, impure carbonate, washed or “elutriated,” after being reduced to fine powder; and (2) *Calcii carbonas præcipitatus*—precipitated calcium carbonate CaCO_3 .

Prepared chalk occurs either in white powder or in small conical masses and is used in *mistura cretæ*, *pulvis cretæ aromaticus*, *pulvis cretæ aromaticus cum opio*, and in *hydrargyrum cum creta*.

Precipitated calcium carbonate, being crystalline and somewhat gritty, constitutes an ingredient of tooth powders, but is not otherwise used except in bismuth lozenges.

CALCII CHLORIDUM—CALCIUM CHLORIDE



CHARACTERS AND TESTS.—This salt has a great absorbent power for water, is deliquescent and very soluble; it occurs in whitish, agglutinated masses of bitter, acrid, saline taste. It must be distinguished from *calx chlorinata* (chlorinated lime), and does not, like that compound, evolve chlorine on the addition of hydrochloric acid.

CALX CHLORINATA—CHLORINATED LIME—BLEACHING POWDER ($\text{CaCl}_2\text{O}_2\text{CaCl}_2$).

CHARACTERS AND TESTS.—It occurs in whitish powder or lumps having the odour of chlorine, and an acrid, caustic taste; if it contain much chloride of calcium it will be moist. It is unstable in composition, readily giving off chlorine when exposed to the air, and being decomposed by any acid, even carbonic. When pure it is wholly soluble in water, but it generally contains some free hydrate, and is only partially soluble. It has powerful deodorant, disinfectant and bleaching properties, which depend on the presence of chlorine, and the test of its value is directed to estimating the amount of this gas (chlorimetry). Thus, by adding hydrochloric acid to chlorinated lime, chlorine gas is liberated, and this being brought into contact with potassium iodide sets free an equivalent amount of iodine, which is estimated by hyposulphite of sodium.

Liquor Calcis Chlorinatae—*Solution of Chlorinated Lime*, being 1 part of the compound shaken up with 10 parts of water—contains about 2 to 3 per cent. of available chlorine.

CALCII PHOSPHAS—*CALCIUM PHOSPHATE (TRIBASIC)*
($\text{Ca}_3(\text{PO}_4)_2$).

CHARACTERS.—A light white amorphous powder, soluble in water.

This form is the one most commonly found in nature, sometimes almost pure (phosphorite), or in friable masses resembling chalk (osteoliths), or in the fossil faeces of ancient saurians (coprolites), in shells and sedimentary earths. From the soil it is absorbed by plants, by the help of water and carbonic acid, and is contained in *seeds*. From plants it is received by herbivorous animals, and in *their* flesh and blood and bone it is sought by the carnivora. It has been said that the amount of phosphate of lime found in different animals is proportionate to the *activity of their movements* (Dusart and Blache). (The salt was obtained formerly for medical use from the excrement of dogs when hard and white, as passed after they have eaten many *bones*; it was known as “album græcum.”) It is contained in *Pulv. Antimon.* and *Ext. Euonymi siccum*.

Besides the tribasic phosphate there are two others, a *neutral* and an *acid phosphate*. The former, $\text{Ca}_2\text{H}_2(\text{PO}_4)$, is a white, crystalline powder, tasteless and insoluble; it occurs in some (carbonated) mineral waters, and may be prepared by mixing neutral phosphate of sodium with chloride of calcium. The *acid phosphate*, $\text{CaH}_4\text{P}_2(\text{PO}_4)$, is very soluble and even deliquescent, and is left in solution when sulphate of calcium is precipitated after treating bone-ash with sulphuric acid.

Calcii Sulphas—*Sulphate of Calcium (not official)*.—This is the native sulphate ($\text{CaSO}_4\cdot\frac{1}{2}\text{H}_2\text{O}$) rendered nearly anhydrous by heat; it is used in the preparation of calx sulphurata.

CALX SULPHURATA—*SULPHURATED LIME*.

This mixture, which is often spoken of as sulphide of calcium, should contain not less than 50 per cent. of sulphide (CaS): the remainder consists of calcium sulphate. It is a grey-white powder of peculiar smell like H_2S , and must be kept in a stoppered bottle.

CALCII HYPOPHOSPHIS—*CALCIUM HYPOPHOSPHITE*
($\text{Ca}(\text{PH}_2\text{O}_2)_2 = 170$).

CHARACTERS AND TESTS.—A white crystalline salt with a pearly lustre and a bitter nauseous taste; soluble in water; insoluble in cold

alcohol. Heated to redness it ignites, evolving phosphuretted hydrogen which is spontaneously inflammable.

Calcium Bromide (*not official*).—Is a white, granular, deliquescent odourless salt, with a pungent, saline bitter taste, and a neutral reaction. (It is sometimes used instead of potassium bromide, and is said not to be so depressant in its action as that salt.) *Calcium permanganate* (Monol) is less nauseous than the potassium salt and a more active steriliser: the *salicylate* (used for diarrhœa, etc.) is white, crystalline, odourless and sweetish; the *bi-saccharate* is in colourless tufts and is soluble in water, antacid, and antidotal to carbolic acid. *Calcium carbide* is an interesting compound, like small coal in appearance, which evolves acetylene gas on contact with moisture.

ABSORPTION AND ELIMINATION.—The various salts of calcium differ somewhat as to their absorption and their action. The *tribasic* and *neutral phosphates*, in small doses (less than 5 or 6 gr.), with but little water, are wholly absorbed under the influence of the acid gastric secretion; but if given with much water, the acids are so far diluted that they do not act upon the insoluble drug, and it passes off mainly by the *fæces*. Raudnitz (Leipzig. Archiv., 1893) concluded that absorption occurred chiefly in the intestines, especially the duodenum, but if large doses be given, the greater part passes out unchanged.

Gouriet has suggested that the solubility necessary for securing the absorption of calcium phosphate is effected partly by means of the sodium phosphate contained in the saliva, partly by the ammonium phosphate and the acids in the stomach juice; when it has passed into the veins, solubility is still further assisted by the carbonic acid present in venous blood. During respiratory interchange of gases, when carbonic acid is given off and lactic and other acids altered, the phosphate that has been taken is only retained in solution by the help of the normal alkaline phosphates of the blood: if these be in small proportion the calcium salts become soon deposited (more in bone than in other tissues), and little passes in the urine: if, however, in any given case the alkaline phosphates be in excess, then most of the calcium salt is retained in solution in the blood until it is (mainly) excreted through the kidneys (Lancet, ii., 1860). This explanation seems rather too chemical, and it must be compared with the

important observations more recently made by Paquelin and Jolly. They conclude that the tribasic phosphate of calcium is not acted upon in the stomach, unless it be by part becoming superphosphate, and this again is precipitated in the intestine under the influence of alkaline biliary and pancreatic secretions, as *insoluble phosphate*; it is not capable of absorption, except in very small quantities; the circulation conveys very little, and the tissues, except bones, contain only traces; the bile has rather more. A certain amount of lime must enter the system from the food, and does so mostly as carbonate, which becomes changed and prepared for absorption by contact with alkaline phosphates and gastric acids, but phosphates given experimentally are eliminated almost entirely unchanged, only some of the acid being absorbed. Hence they conclude that the addition of such compounds to the food is rather an obstacle to nutrition, and that even the soluble acid preparations (lacto-phosphates, etc.) act only as acid principles, and pass out of the system as phosphates of another base. The calcium phosphate contained in urine and phosphatic calculi even when primary, is said to be almost entirely formed within the bladder. These views, as they are not quite in accordance with commonly received clinical evidence, seem to require confirmation, but they suggest moderate expectation of cure by calcium salts.

The bicarbonate, as occurring in Carrara water, is soluble by virtue of the excess of carbonic acid, and readily absorbed. *The neutral carbonate*, in small doses (5 or 6 gr.), is soluble in the gastric juice, and is absorbed as a *chloride*. The *chloride* itself in similar dose, and even up to 15 or 20 gr. diluted sufficiently to disguise its caustic taste (as with 3 oz. of sugared water), may be absorbed without gastric disturbance, and is rapidly excreted by the kidneys; larger doses are apt to cause a sense of oppression, with nausea and diarrhoea. According to Perl the chlorine passes in the urine, the lime mostly in the fæces (Virchow's Arch., 1878). Unduly large doses of lime-water, or of phosphates or carbonates, may also cause gastro-intestinal irritation.

Of that which is absorbed an equivalent quantity is eliminated, except during the period of growth, and especially of bone-development. There seems to be a power of laying-by some of the substance for this purpose, *e.g.*, during the early

months of pregnancy bony growths (osteophytes) sometimes form in the bone of the parent, which diminish with the growth of the fœtus. The excreted calcium is found in the urine as acid phosphate, and in many other secretions such as the pancreatic juice; some may be detected in plastic exudations; sometimes it forms calculi. It is often deposited in tumours, fatty, fibrous, and sarcomatous, and in old inflammatory exudations, as in tubercle of the lung and strumous glands.

Some recent researches by Hoppe Seyler show that the elimination of lime salts is much augmented during prolonged rest in bed, although after a time it becomes again of average normal amount: it is increased also under mercurial treatment, diminished during febrile maladies (Rev. Sci. Méd., 1891); about 45 gr. are daily eliminated by an adult man.

PHYSIOLOGICAL ACTION.—*External.*—Lime unslaked, or “quick,” decomposes and destroys organic matter, and is used sometimes as a caustic, more often as a disinfectant, *e.g.*, in dissecting-rooms and in grave-yards; its affinity for water and its ready combination with sulphur (as in sulphuretted hydrogen) will explain its good effects. It is used by tanners to remove the hair from hides, and by farmers as a fertilising agent. Its action upon the living skin is irritant and to some extent caustic, but as it has less “diffusion power,” this is more superficial and more limited than that of the alkalies proper,—potash and soda. On the mucous membranes, however, its effects may be very severe, as when by accident it enters the eye, or when too strong a solution of it, or of its haloid salts, is taken into the mouth. Local inflammation and ulceration may follow, and even a fatal result be produced when the stomach is affected. Hypodermic injections of chloride cause sloughing.

Weak solutions or the neutral salts, carbonate and phosphate, in powder, have a local astringent and sedative effect. The “lime-water” of the Pharmacopœia is not strong enough to be caustic, but controls secretion especially from mucous membranes, and renders the tissues pale and dry. Finely powdered chalk, mixed with a little chloride and phosphate, is a good local hæmostatic (White, Lancet, 1896).

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—Lime-water and calcium carbonate, when taken internally

in moderate doses, produce similar local astringent and sedative effects, and act also as absorbents and antacids. The phosphate is astringent to some extent, but the sulphate may alternately confine and relax the bowels, according as astringent or irritant effects are produced.

Circulatory System.—Dr. Ringer points out that calcium salts play an important part in the circulation and in most of the other functions of the body; the heart, or any other muscle deprived of calcium will no longer contract. In the case of the frog's heart, this fact can be illustrated by the following experiment: by means of a perfusion-cannula, normal saline solution (*i.e.*, 0.6 sodium chloride) can be passed through the heart, which gets gradually weaker and weaker, and finally stops in a state of systole, but resumes activity when a trace of calcium salt is added to the saline mixture; the beat becomes perfectly normal and will continue for many hours after the further addition of a trace of a potassium salt. This saline fluid will, in fact, keep the heart alive as long as one containing blood (B. M. J., i., 1885).

Fishes immersed in distilled water soon die; in tap water they live a long time, but they live almost equally well in distilled water to which a trace of calcium chloride is added (Journ. Physiol., vi.). Blake had previously shown that calcium, barium and strontium exert a similar action (Pract., 1884).

Dr. Ringer has written also on the coagulating power of calcium salts (Journ. Physiol., 1892) and 1 per cent. of the chloride is added to complete the preparation of the "fibrinogen styptic" which has remarkable power of arresting hæmorrhage (Lancet, i., 1893). Dr. A. E. Wright, of Netley, has demonstrated by means of his capillary tubes and by clinical evidence the effect of the salt alone in increasing coagulability; curiously, however, when an excess has been taken an opposite effect follows (B. M. J., ii., 1891-94). Dr. Butler states that it may cause cyanosis by chemical change in the blood (Diagnostics of Int. Med., p. 78).

Nutrition.—The most interesting point in the physiological action of calcium salts is their influence on nutrition,—the necessity of phosphate for healthy growth, whether vegetable or animal, being especially evident. Experiments with plants have shown that the phosphates are in close relation with the nitrogenous elements. If, for instance, the nitrogenous husk or coating of a

seed be removed, the phosphates are removed with it, and in the starchy part of the grain none are found. In the leaves they occur in the parenchyma, not in the nervules, and generally are most abundant in the cellular parts of vegetables wherein nutrition and reproduction are most active (Liebig). Wheat planted in earth containing phosphates germinates and thrives, but if all phosphate of calcium be removed, it germinates but soon dies. Peas (which contain a larger proportion of azotised matter), when similarly treated, germinate and even bear a crop, but if this crop be sown in a soil without phosphates it does not flower (Ville, Conférences, Paris, 1865). That the improvement in nutrition is not due to the presence or absence of *phosphorus* as such, but to phosphate of lime, is shown by experiments on birds. Wheat contains a large quantity of *phosphate of potassium*, and when pigeons are fed upon this alone and are prevented from getting any carbonate or other salts of calcium they waste away, and their bones become weak and brittle. If, on the other hand, they can obtain lime in any form it becomes changed into a chloride during digestion, and, combining with the alkaline phosphates of wheat, provides them with calcium phosphates and secures or favours their due nutrition (Chossat).

There is also evidence that calcium phosphates serve especially to nourish cartilage, bone, tendon and muscle, so that they have been fairly called "restorative or analeptic tonics" to the *locomotor* organs, as iron is to the blood, or phosphorus to the nerve-tissue. Thus, as the result of observations on the reproduction of the shell in crabs, Schmidt found that a combination of phosphate of calcium and albuminous material was most favourable for the formation of osteoid cells; phosphate was required for the first growth, though carbonate was formed later. Mr. Bridgman noted the formation of "artificial cartilage" by the passage of an electrical current through a viscous solution of carbonate of calcium (Lancet, i., 1863). Beneke found that phosphate of calcium was specially abundant in plastic exudations and wherever new growth was going on, and he adopted the microscope as a ready means of its detection—for if a drop of sulphuric acid be added to the liquid, crystals of calcium sulphate are very quickly formed (Lancet, i., 1851). The organism can assimilate phosphate of calcium either in the soluble acid form

(for the liquids and soft tissues), or to some extent in the basic insoluble form (for the skeleton); but its effects are produced slowly, and without the evident stimulation which we associate with the action of wine, iron, or quinine, so that we describe such calcium compounds rather as restoratives than as general tonics, and as *modifying* rather than *stimulating* nutrition.

Besides their effect on ossification, etc., M. Mouriès, a distinguished chemist, has described a special effect of calcium salts upon "irritability" or vital organic changes, so that if these salts are *absent*, assimilation and nutrition do not go on and emaciation and death ensue, whilst if they are simply *deficient*, various degrees of lymphatic and osseous disease are produced. He has calculated especially that the food of those who live in towns is deficient in these principles, and that whilst every one ought to have at least 90 gr. daily, many, women especially, receive only about half that quantity; hence a secretion of poor milk and consequent weakly children, and he claims that by the use of a certain food containing calcium phosphate with albumin, the proportion of still-born and of rachitic children in many families has been markedly reduced (quoted by Trousseau).

Any difference in the amount of urea and carbonic acid excreted under the influence of phosphate of calcium is not easily ascertained. The chloride of calcium is said to increase the amount of urine (Giacomini); and it is probable that like other chlorides it increases the excretion of urea (Rabuteau). Drs. Chittenden and Ely have shown that a small percentage of calcium phosphate increases the diastatic action of saliva (Pharm. Journ., 1883).

Lime in Potable Waters.—Waters that do not contain lime are flat and insipid, whilst a proportion of from 7 to even 20 gr. of carbonate in the gallon is compatible with their being good, wholesome and pleasant (Parkes); such waters may be rendered sufficiently "soft" by boiling. Hardness dependent upon a soluble bicarbonate of calcium is best treated by Clark's process of adding slaked lime, which precipitates an insoluble carbonate.

Calcium sulphate is contained in water from selenitic rocks, and a proportion of from 6 to 21 gr. per gallon was pronounced unwholesome by Parent Duchatelet on account of irritation of the bowels apparently caused by it in some prisons and hospitals of Paris, but even a higher proportion in some waters, *e.g.*,

Contrexéville, which has nearly 10 gr. in the pint, does not usually disagree. Such water is not much softened by boiling. *Calcium nitrate* is sometimes found in drinking water, being derived probably from organic sources; it is likely to cause diarrhœa.

Water from *magnesian limestone*, containing magnesia with some *carbonate*, and 4 to 12 gr. per gallon of *sulphate* of calcium, has been considered especially likely to cause *goitre*; but professional opinion, though still divided on this question, is now more inclined to the negative view. Dr. McClelland gave some remarkable instances from villages scattered over a large district in Bengal where the inhabitants, though living close together, were affected with *goitre* or not, according as to whether they drank or not of certain wells, to which they were restricted according to caste, and he found that the wells used by goitrous persons contained a large percentage of calcium carbonate (Brit. and For. Rev., 1861: Watson's Practice of Physic); the presence of magnesia is not mentioned. Dr. Inglis in his treatise on the subject, Dr. Coindet of Geneva, and other authorities have agreed in blaming lime-waters mainly for the production of *goitre*, and its greater prevalence along ranges of lime-rock, as in Nottinghamshire, Derbyshire, and parts of South America, is quoted in favour of the same view. Some connection has been further traced between this cause and *cretinism*, as well as *goitre*; and Köliker and others maintain, not without the support of *post-mortem* evidence, that by the habitual use of such lime-compounds ossification is increased at the base of the skull, so that the cranial foramina become narrowed, and the supply of blood to the brain lessened. On the other hand, Dr. Mitchell has published a careful report upon the "Nithsdale neck," prevalent in that part of the south of Scotland, and has shown that some other element than the water must be concerned. It is true that many of the wells used contained from 4 to 14 gr. of carbonate in the gallon (with magnesia), but that limit is compatible with health, and several wells in the same district contained the same quantity, and even to 24 gr., without the production of any *goitre* (Brit. and For. Rev., April, 1862).

Dr. St. Lager has given a list of villages in the Department of the Drôme with limestone-waters and no *goitre*, and the same conditions are found along the right bank of the Isère and on the

gypsum beds near Paris: on the other hand, he adduces much evidence that sulphide of iron (pyrites) is the *fons et origo mali*. This can be found—in the form of marcasite—in the southern counties of England—Wilts, Hants, Kent, etc.—together with chalk and chalk marl (B. M. J., ii., 1896).

SYNERGISTS.—Alkaline and earthy bases have a similar absorbent action to that of the *carbonate of calcium*, and reconstituents generally, such as iron and cod-liver oil, are adjuvants to the calcium phosphates; aromatics also are often well combined.

ANTAGONISTS AND INCOMPATIBLES.—Mineral acids, laxatives and irritants either decompose or neutralise the action of lime compounds, with the exception of *phosphoric acid*, which is sometimes used with the acid phosphate to render it more soluble. Dr. Wright has shown that vegetable acids, as in fruits and in wine, also alcohol *per se*, all interfere with the due action of lime salts as regards coagulability of the blood (B. M. J., ii., 1894).

Saccharated lime is said to be a specially good antidote to *carbolic acid*, and the following is Ferraud's formula: Sugar 15 parts, water 40 parts; dissolve, and mix thoroughly with quick-lime 5 parts (Lancet, i., 1876). *Hypochlorite of calcium* is an antidote for sulphuretted hydrogen.

THERAPEUTICAL ACTION.—*External.*—**Epithelioma.**—A mixture of quick-lime (2 parts) and caustic potash (1 part) is sometimes a useful escharotic for superficial forms of epithelial cancer; it should be mixed just before using with sufficient alcohol to form a paste ("Vienna paste"), and spread over a suitable aperture in diachylon plaster previously placed on the part; its action begins immediately and lasts for about half an hour; the eschar is dark-coloured, and separates in from ten to twelve days. A proportion of 6 parts of lime to 5 of potash is recommended by some authors, and for application to deeper-seated parts, such as the neck of the uterus, a combination of 1 part of lime with 2 of potash is used, especially by French surgeons ("caustique Filhos"); it is fused by heat, and poured into a small mould of lead, which can be cut away as the caustic is required.

Onychia.—Prof. Vanzetti has recommended the application of caustic lime in preference to nitrate of lead for onychia maligna, and has reported two successful cases, in one of which the

application was renewed several times, and in the other it was left in continuous contact (Pract., vol. xiii.).

As a **Depilatory** to remove superfluous hair, lime is sometimes used with arsenic (as in the Turkish "Rusma"), or in the form of a hydrated sulphide, prepared by passing sulphuretted hydrogen through a mixture containing 2 parts of lime with 3 parts of water : when saturated with the gas this forms a greenish jelly, which is spread upon the part for a few minutes, and then removed with an ivory knife (Boettger quoted by Trousseau, *Traité*, t. i.). This has also been used in Tinea and is said not to cause undue irritation.

As a **Moxa**, or to produce an issue, a fragment of lime may be slaked on the skin by adding to it a few drops of water ; much heat is produced, and the neighbouring skin requires to be protected.

As a **Vapour Bath**, a piece of unslaked lime half the size of a man's closed hand is wrapped in a moist cloth, and this again in a dry one doubled several times and fastened securely : if one of these packets be placed on either side of a patient whilst in bed, the moist heat soon induces a copious perspiration lasting for one or two hours. Dr. Hassall has recommended this as a ready means of establishing reaction in cholera, and others have used it in tetanus.

Hay Fever.—In this malady the vapour evolved from chlorinated lime has been found serviceable when the air of the patient's house is impregnated with it as far as possible ; the solution should be used as a wash to the face and hands. It probably acts by destroying the activity of the pollen grains which form the source of the irritation of the mucous membrane, especially of the nose.

Diphtheria.—In the form of a warm, finely atomised spray, solutions of lime (1 in 30) have been much commended as chemical solvents of diphtheritic membrane. Förster, Biermer and others have shown that such membranes, and especially their fibrinous constituents, are soluble in lime-water (*Archiv der Heilkunde*, v.), but doubts have been expressed whether such an effect can be usefully and practically obtained in the living body. Biermer treated a case of diphtheria by means of a warm lime-spray, and although the patient was in great peril, he obtained relief and finally recovered ;—this physician, however, generally gave calomel at the same time (*Brit. For. Rev.*, 1865).

Kuchenmeister has recorded several good cases treated successfully by the spray (Bull. Gén., 1865), and the experience of Steiner proved that diphtheritic layers on the fauces were dissolved by it in a marked manner: subsequently, however, the growths formed again, and could not be controlled by the remedy (Jahrb. für Kinderheilk., 1870). Beigel has reported good results with it in "croup," and Geiger in diphtheria (Pract., i.); but Senator has more recently written against its employment, even from a theoretical point of view, and doubts its power of dissolving membranes *in situ*. Gottstein and others consider the direct application of lime-water to the larynx by means of a brush to be more advantageous than the spray, and Albers in desperate cases injected the solution into the larynx from below, passing his syringe between the tracheal rings: cough was caused, and shreds of membrane were ejected (Berlin klin. Woch., 1869). Mackenzie found it useful "when the false membrane is not very thick," but there are better remedies for the same purpose.

Lactic acid and carbonate of lithium act similarly; Kuchenmeister, however, still maintains the superiority of lime-water. Sanné recommends the saccharate of lime.

Cancrum Oris—Ulcerations.—Applied in substance or in weak solution, chloride of calcium is a valuable antiseptic and stimulant to foetid discharging surfaces. In cancrum oris a little of the powder may be applied by the finger, and washed away immediately afterwards; and in unhealthy ulcerations about the gums in general, and in salivation, a wash may be used containing 2 dr. to the pint of water with glycerin; or ordinary lime-water may be used with nearly equal benefit.

A proportion of 1 to 10 or 15 of water has been found extremely useful applied as a compress in cases of ruptured perineum, when the torn surface is apt to discharge offensively; and in unhealthy and indolent ulcerations of any part, the same remedy or even ordinary lime-water will diminish discharge, cleanse the surface, and promote a healthy action. Weak chloride of calcium lotions are also good in *erysipelas*. In snake-bite Calmette recommended local injection of calcium chloride solution for an effect on the blood, but whatever value it possesses seems to be due to its destroying the poison *in situ*, and causing the affected part to slough (B. M. J., ii, 1895; Ep. 1881).

Skin Diseases.—In pustular and erythematous skin diseases preparations of lime are often very useful. In *chronic acne* I have often ordered lime-water mixed with an equal part of rose-water, and applied three or four times daily, with the best results. In *ecthyma* it is commended, and in the discharging stages of *eczema* and *impetigo* it makes a useful lotion, more effective with the addition of zinc oxide, bismuth, calomel or black wash. In *impetigo capitis*, and in *fissured nipples*, lime-water mixed with oil is good. In chronic eczematous and scrofulous disease calcium salts are often useful when given internally (Tilbury Fox speaks well of “saccharated wheat phosphate” in such conditions). Cazenave thought the chloride good in lupus. Dr. Spender finds that in chronic *dermatitis* eczematous in origin, finely levigated chalk made into an ointment with lard and a little tar ointment is most useful; in some cases a small percentage of blue ointment in addition is serviceable (Pract., i., 1883). In *carbuncles* and *boils* a compress soaked in lime-water and covered with oiled silk often acts beneficially; it checks inflammation, soothes pain and promotes suppuration more quickly than ordinary poultices. In *erythema* and the *pruritus* of reddened irritable skin lime-water has a sedative, moderately constringing effect, and may be used either alone, or as a vehicle for other similar remedies. In *pruritus pudendi* it is often useful when applied freely and tepid, and in *osmidrosis* it will relieve the unpleasant secretion from the sweat-glands. Dusting powders containing prepared chalk are used for *erysipelas* and *erythema*, and in cases of much sebaceous secretion, especially about the face. Combined with lard as “chalk-ointment” it is often a good application for indolent and irritable sores. In *tinea capitis*, after thorough cleansing, lime-water may be brushed in, but as a rule stronger remedies are necessary: a lotion of the chloride is more satisfactory. In *scabies* a strength of 1 oz. of chloride to 1 pint of water has been found sufficient to cure, but a more dependable preparation is made by boiling together 1 part of quick-lime and 2 of sulphur with 20 of water down to 10; this should be constantly stirred till well mixed, and the liquid poured off for use; it is too strong to be rubbed in like sulphur ointment, but should be applied lightly with a brush, and afterwards removed with a warm sponge, if necessary (Lancet, i., 1865). Pharmacists

now commonly make such a preparation under the name of liquor calcis c. sulphure (*v. Sulphur*).

Burns and Scalds.—Lime-water, mixed with an equal part of linseed oil ("Carron oil") or, better, of olive oil, was long since commended by Boyle and by Velpeau as a suitable dressing for the early stages of burns in every degree, and though rather unpleasant it has come into general use. It may be applied on carded cotton, and, if the skin be unbroken, resolution of inflammation is promoted by it, whilst if suppuration occur the liniment controls it, and hastens cicatrisation. It relieves pain and inflammation in cases of wasp and other stings (*Dauverne*).

In severe cases of **Small-pox** Dr. Joseph Bell recommended the same liniment to be applied to the face on cotton wool, carefully arranged to cover the affected part, but leaving apertures for the eyes, nose and mouth: the wool should be fastened with another covering or with tape, so as to prevent admission of air, and by this means pitting may be prevented or decidedly lessened. An improved formula is a saturated solution of lime, made with sugar, water and glycerin, which forms a cool, drying varnish, and for burns may be well diluted with oil, or ether may be added (*Pharm. Journ.*, Oct., 1873); the latter rather irritates.

Chronic Discharges.—In chronic mucous and purulent discharges, lotions and injections of lime-water exert a most beneficial influence, as may be observed in chronic urethritis and in leucorrhœa, syphilitic or otherwise; in the former a combination with mercurial oxides, such as the "black or yellow wash," is still more potent, and is in daily use for all forms of syphilitic ulceration.

The profuse nasal discharge so usual in scarlatina, and also muco-purulent otorrhœa, may be well and safely treated by washing out the affected parts with a tepid injection of milk and lime-water three or four times daily: over the affected ear a compress of lime-water, worn at night, is often advantageous. In chronic purulent ophthalmia a very weak lotion containing chloride of calcium is said to be effective.

Ascarides.—Rectal injection of a few ounces of lime-water several times repeated is effectual in curing ascarides, and Dr. Price and Kuchenmeister have reported some cases of successful instances of this treatment (*Lancet*, i., 1864); it has long been a favourite prescription of mine.

THERAPEUTICAL ACTION.—*Internal.*—Lime-water was formerly much esteemed as an internal medicine, and was given not only as an antacid and astringent, but also as an antiseptic, and especially as a lithontriptic or solvent of calculi. It was not unfrequently given in excess and produced irritant effects, but its use now is more restricted, and the doses given are smaller and more diluted.

Dyspepsia.—**Vomiting.**—When digestion is accompanied with discomfort and oppression, or with acidity, pyrosis and flatulence, especially if there be a tendency to diarrhœa and to acidity of urine, lime-water and the carbonate of calcium are often more serviceable than alkalies, because they are not only antacid but astringent. I have found them especially useful in the dyspepsia of chlorotic women marked by the above symptoms, and generally by craving for acids and dislike to animal food. G. Sée advises the chloride (*Internat. Journ.*, i., 1892). When flatulent distension affects the lower bowel, lime-water has been used in enema as an absorbent of carbonic and other gases; Dr. Habershon has recommended the carbolate of calcium in such conditions (*Lancet*, i., 1868). For cases of acid dyspepsia, when flatulent distension is not so prominent a symptom, but when there are heartburn and pain with evidence of gastric congestion, the bicarbonate of calcium dissolved with an excess of carbonic acid in the slightly effervescent form known as Carrara water is very useful, for it is less nauseous to some patients and more easily tolerated than lime-water, so that more of it may be given at a time; it may be mixed with an *equal* part of milk, whilst of lime-water not more than *one-eighth* part should be used. (It is not now easily obtained.)

For the special symptom of nausea and vomiting from irritative gastric conditions, milk and lime-water is a simple and effective treatment; given frequently in small quantities, iced, it provides digestible nourishment which is sometimes better retained than any other. It is valuable in the vomiting of pregnancy, and even in that of gastric ulcer, in which latter malady only a dessertspoonful in a wineglassful of milk should be tried at a time. The lime acts partly as a sedative to the mucous membrane, partly as an antacid, and partly mechanically by breaking up the curd of milk; hence it is particularly useful as

an addition to cow's milk for children brought up by hand, only in any case where constipation is marked barley-water or soda-water may be substituted for a time. It is not to be looked upon as supplying additional lime, since the small amount contained in liq. calcis is really less than that in an equal bulk of milk (Bunge).

Mr. Metcalfe Johnson has written highly of the value of hydrated *phosphate* of calcium in the sickness of pregnancy, and Dr. Leared of the chloride in sarcinous vomiting. Dr. Cleland specially recommends the saccharate as a better antacid than magnesia, and useful in dyspepsia dependent on either too little or too great secretion of gastric juice; it does not constipate like other lime compounds; it may, however, cause nausea if taken on an empty stomach (Edin. Med. Journ., 1859). Many natural mineral waters containing lime, such as Seltzer, Kreuzbrunnen (with soda) and Pougues, are of acknowledged value in gouty and acid forms of dyspepsia, etc.

Intestinal Catarrh.—Diarrhœa.—Lime-water and calcium carbonate are useful in these conditions, especially if gastro-intestinal acidity be present, as it usually is in young children; the breath is then offensive, the motions frequent, loose, greenish, sour-smelling, and deficient in bile; the abdomen is distended, cramping pain occurs at intervals with drawing-up of the legs, and there is often sickness. Restriction to milk and broth diet, with the addition of 1 or 2 gr. doses of carbonate of calcium will often cure this disorder; in the diarrhœa of dentition, as well as in the more chronic forms connected with strumous or mesenteric disease, such treatment is specially indicated. (Castor oil may be required at first to remove any cause of direct irritation such as undigested food, mucus, etc., and the use of insoluble calcium salts should not be prolonged more than necessary, otherwise irritation, or some degree of obstruction may be caused.)

In *chronic diarrhœa* dependent upon a relaxed condition of the alimentary canal, and also when kept up by ulceration of the bowel, I have used lime preparations with the best possible effect. Bretonneau recommended them in enema for these cases.

In the *diarrhœa of enteric fever* and of *tuberculosis* milk and lime-water may prove of great, if only temporary service, but should not be used in large quantities if hæmorrhage or symptoms

of acute inflammation be present. The alkaline earth is plausibly supposed to combine with the secretions of the ulcerations and to form a layer which protects the terminations of sensitive nerves against contact with the contents of the bowels. Mialhe especially applied this explanation to the phosphate of calcium, which salt has been much used in the treatment of diarrhœa and of acidity, and owing partly to its phosphoric element is considered to exert a special restorative power: according to him, if given with bread and sugar, it becomes changed by the slight acid of the former and by the gastric acids into a soluble acid salt, which does not itself coagulate albuminous material, but when brought into contact with a small proportion of alkali becomes converted into an insoluble basic phosphate of gelatinous character, which protects the mucous membrane, and checks diarrhœa: the nitro-phosphate is said to be especially good (Pract., v., 28).

This salt was the principal ingredient in the "white decoction" of Sydenham. The quinovate of calcium is specially commended by Kerner (*v. Vegetable Kingdom*).

Aphthous conditions of the mouth and alimentary tract, when occurring in infants with green, but not necessarily liquid stools, may often be cured by lime-water or prepared chalk.

Pruritus.—Urticaria.—Dr. T. D. Savill has recorded several striking cases of pruritus rapidly relieved by full doses, 20 to 30 gr. and upwards of the chloride, after failure of other remedies. He gives reason for believing that a change in the blood irritates the terminal nerve fibrils and that the drug acts by modifying this blood change; given with tincture of orange and chloroform water after food, he finds the full doses well borne (*Lancet*, ii., 1896). These results require confirmation.

Dr. Wright having found deficient coagulating power of blood in cases of urticaria and of chilblains—as well as in lymphatism—has also given full doses of chloride in these complaints, and generally with good results (*ib.*, i., 1897).

Bone Disease.—Fractures.—Piorry furnishes evidence of the value of phosphates in osteo-malacia, or softening of the bones generally, also in spinal caries or "Pott's disease" (*Gaz. des Hôp.*, 1856), and I have certainly seen them beneficial in cases of caries and joint disease. Reasoning from the observation that birds with a broken limb lay eggs without shell during

the process of repair, Dr. Fletcher was led to administer a mixture of calcined bone, prepared chalk and lime-water in cases of fracture (in man), and reported several cases of very early union of long bones (Lancet, 1846). Milne Edwards made similar observations on dogs and rabbits, producing fractures as nearly as possible alike, and then finding that the animals who got calcium phosphate recovered more rapidly than the others; and M. Gosselin found the same results in men (*Comptes Rendus*, xiii.); on the other hand, it has been held that in fractures of old persons, in whom the bones are brittle, calcium salts are better avoided. They have been strongly recommended during pregnancy and lactation in enfeebled mothers, both to relieve their neuralgia, debility, and dyspepsia, and also to favour the development of healthy non-rachitic children; and I have for years recommended their use in backward dentition, delayed power of walking, and retarded closure of the fontanelles. These are usual signs of a rachitic tendency, and in the fully developed malady of rachitis, saccharated lime is strongly to be recommended. It is true that although parts of the bones become softened in this disease and are deficient in lime, often at the same time calcium phosphates are largely excreted in the urine, so that the fault is one rather of mal-assimilation than of actual deficiency, yet I agree with Dr. Ringer that the administration of lime, and especially of calcium phosphate, "appears to control this defective and perverse nutrition, and to induce healthy growth, so as to favour consolidation of the skeleton and improve the condition of soft parts," and that practically they are extremely valuable, though not always alone curative. He compares this use of it to that of iron in anæmia, where the fault is equally one of want of assimilation rather than of quantity. Considering, however, the insolubility of ordinary tribasic phosphate, M. Dusart and others have introduced acid solutions—lacto-phosphate—acid phosphate—which are sometimes suitable, but in rachitic children the secretions are often too acid, and need to be neutralised by a basic earthy salt; any excess of acid would tend rather to dissolve osseous salts, and cause them to be eliminated, not deposited. It may often be better to give the ordinary salt (phosphate) recently prepared if possible, and with flour or milk, and to trust the stomach to absorb what is needed, and the surplus will pass through the intestine.

The combination of calcium phosphate with sodium chloride (*calcaria phosphorica salita*) has been found very soluble (Sabellin, Husemann). The *sulpho-carbolates* of calcium have been specially recommended in rickets.

Some have thought that natural salts of calcium, such as have recently passed through *organic* structures, were preferable to such as have been deposited as *mineral*. Thus, Piorry recommended in softening of the bones and spinal curvature fine filings of fresh bone, 1 oz. to be taken in milk or rice-milk, and found it succeed when light, warmth and food had failed (*Gaz. des Hôp.*, 1856; *Med. Times*, 1857).

Others have derived medicinal phosphates from the *vegetable* kingdom. Thus Dr. Hake and Dr. Tilbury Fox recommended a strong decoction of bran to be made and evaporated, and the residue mixed with sugar; and a preparation of this kind known as "saccharated wheat phosphates" came largely into use for malnutrition, rickets, etc. (*Med. Times*, i., 1866). The advantage of calcium salts in bone disease is not traced simply to chemical and physical processes, but also to direct improvement of digestion, absorption and nutrition, and such substances as cod-liver oil often produce greater benefit in rickets.

Glandular Diseases.—Lime-water was long since commended for the treatment of suppurating glands and of ulcerations, as well internally as locally (Shapter, Pereira). The phosphate was especially found serviceable, though not always curative, in the different manifestations of struma by Beneke (*Lancet*, 1851) and by Stone; whilst Dr. Beddoes collected upwards of 100 cases, including many of so-called "tabes mesenterica," benefited by the chloride, and Dr. Begbie has corroborated the good results to be obtained from doses of 10 to 20 gr. daily. He records also the subsidence of enlarged parotid and lymphatic glands under the same medicine, when iodine and cod-liver oil had failed to cure (*Edin. Med. Journ.*, 1872). In one very chronic case with many glands affected, this salt, commenced in 10 gr. doses and gradually increased up to 40 gr. and continued for twelve months, had a distinctly good action in lessening the size of the glands (Coghill, *Pract.*, 1877-1885). Dr. Crighton found it effective even when suppuration had occurred—and this is reasonable, though not commonly accepted: he refers to cases of tuberculous

caries and of *tabes mesenterica*, and found the crystallised salt better than the anhydrous.

Of late years a mineral water in the West Indies has obtained great repute in the treatment of glandular enlargements, and has been found to contain calcium chloride, though in small proportions: the Bridge of Allan, Llangammarch and other waters also contain it. I have myself given it a fair trial in 1 to 5 gr. doses twice daily for lymphatic disease in children, and have sometimes seen good results from it when persevered with, though, as a rule, I prefer the carbonate to other lime compounds.

Sulphide of calcium is of proved value for tuberculous sores and enlarged glands, and for localised suppurations of all kinds (*v.* Sulphur).

Anæmia.—In anæmia and debility, the consequence of overwork and close confinement, or when affecting the young or suckling or menorrhagic women, Dr. Ringer speaks highly of the phosphate of calcium, especially when combined with the carbonate and with iron.

In nervous disorders with sleeplessness, and in infantile convulsions, Dr. Hammond has found the *bromide* of calcium more readily taken and more effective than that of potassium, and I can to some extent confirm his observations. It is richer in the bromine ion than many other bromides.

Phthisis.—Chronic Bronchitis.—In the early stages of phthisical anæmia and debility, especially in excitable florid persons with tendency to headache and dyspepsia, also when in later stages profuse sweating, or expectoration, or diarrhœa is present, or when the menses are frequent or profuse, the carbonate or phosphates of calcium often exert a good influence in lessening such discharges and in improving strength; even when actual softening has occurred and cavities formed, I have given these salts with the object of assisting cretaceous deposits and often with benefit. Lime well supplements cod-liver oil, and the two remedies may be suitably combined, since they form an emulsion readily taken by children— $1\frac{1}{2}$ part of lime-water to 1 of cod-liver oil is perhaps the best proportion (*Med. Times*, i., 1862). Van den Corput, though praising this combination, recommends rather the chloride flavoured with anise and such proportions of lime-water, etc., as will make a solid jelly (“*jecoro-calcaire savon*”), which is still better taken (*Med. Times*, ii.,

1870); it has not, however, come much into use in this country. Cod-liver oil does not mix well with syrup of lacto-phosphates, and is liable to become rancid when in contact with it. At a hospital in Moscow excellent results were obtained in the treatment of phthisis by freshly calcined bone.

The hypophosphites of lime were introduced as the best compound for the treatment of phthisis, owing their value in part to the base, and in part to the hypophosphorous acid contained. The extravagant praise which was bestowed upon them has not been supported by the majority of the profession, and opinions are still divided as to their real powers,—I believe that they are sometimes of much service. Rabuteau remarks that as hypophosphites raise animal temperature, the *phosphates* would seem more rational remedies for phthisis; that dogs never (?) have phthisis, probably because they eat so much bone; also that phosphates are commonly in excess in the urine of the phthisical, and therefore to supply them artificially is reasonable. Charters has published illustrations of their value in night-sweats (Lancet, 1876), and Gugot has made a similar observation (Husemann). Mr. Pidduck specially praises the iodide of calcium in tuberculosis. It is tasteless, non-irritant, easily decomposed, but does not readily produce iodism (Med. Times, i., 1858). The chloride, in 10 gr. doses with 1 dr. of water and of glycerin, taken in milk after meals, is said to “check night-sweats, increase weight, and dry up pulmonary lesion” (B. M. J., i., 1880). The use of calcium salts in this direction has been revived by Dr. Kolischer of Vienna under the title of a “cure for consumption”.

In *chronic bronchitis* I have frequently seen lime-water and also carbonate of calcium act well in diminishing profuse expectoration and troublesome cough; it should be given internally, and the lime-water applied locally by an atomiser. In *gangrene of the lung* Dr. Graves advised the chloride with opium.

Cancer.—Besides the local application of lime-water and calcium chloride to cancerous sores, a power has been claimed for these remedies, taken internally, to diminish malignant growths; thus, a curious case, in which an extensive mammary cancer separated and fell off after a prolonged use of calcium carbonate, is recorded by Dr. Peter Hood (Lancet, 1867); the patient was advanced in years, and for a long time took the carbonate as

prepared from the inner side of oyster-shells, 10 to 20 gr. twice daily; another case which recovered after taking the same remedy is also mentioned.

If the taking of calcium salts has any power in inducing the calcification of tubercle—and there is some clinical evidence to that effect—and if they can diminish the blood-supply of a fibroid tumour and hasten calcareous degeneration of it, then it is not unreasonable to expect advantage from them in some cases of cancerous degeneration.

Menorrhagia.—Fibroid Tumour.—Hæmorrhage.—Dr. Wright in accordance with his proofs of the chloride increasing coagulability of the blood has advocated its use in all forms of hæmorrhage, epistaxis, hæmoptysis and hæmophilia, and has published good instances of its power, especially when combined with inhalations of carbonic acid (*Lancet*, i., 1896).

Dr. Parry reports benefit from repeated doses in a case of gastro-intestinal hæmorrhage in an infant (*ib.*, ii., 1898); and M. Sympson in hæmophilia, has adopted the practice of giving it for some time before major operations and confinements (*ib.*, i., 1899). Many leading surgeons now administer the chloride before operations in which profuse hæmorrhage is anticipated. It is a curious fact—noted by Wickham Legge—that many hæmophiliacs have a habit of eating lime, in the shape of plaster, as if it supplied a want.

There is a consensus of opinion as to the power of calcium salts to relieve uterine hæmorrhage. Dr. Rigby published a marked case dependent on “fibrous tumour” treated by the chloride (*Med. Times*, 1854), and Drs. Rogers, Routh and others have recorded similar experiences; doses of 10 minims of the liquor calcii chloridi (B. P., 1894), increasing by degrees to 30 or 40 minims, and continued for some months, are recommended (Ranking, 1871; *Lancet*, 1873). In too early and too profuse menstruation I have been accustomed for many years to prescribe calcium carbonate with success. Sir Spencer Wells taught that the chloride acts by leading to atheroma of vessels, and hence is useful in lessening the growth of uterine fibroids and may even cause their disappearance (B. M. J., 1868). Certainly in some instances under my care, uterine and other tumours have diminished under treatment by these salts.

It is true, as remarked by Dr. Meadows, that large quantities have been given to many patients with uterine fibroid tumours without any result, and he ridicules the idea of any possible promotion of calcification by such means (Lancet, 1873), admitting only that a natural process of atrophy may occur, of which calcareous degeneration is a consequence, not a cause: he ridicules equally the idea of lime curing rachitis.

Uric Acid Deposits.—Vesical Calculus.—In these maladies lime has not retained the reputation it formerly held, but it may give some relief. The secret remedy of a Mrs. Stephens received so much commendation about one hundred years ago, that Parliament purchased the recipe for £5,000 and it was found to consist mainly of calcined egg-shells (calcium carbonate) and soap with vegetable bitters, and though benefit may be set down to the alkali of the soap, yet Whytt obtained very good results afterwards from simple lime-water. This was also the liquid used in the noted “Adam’s specific solvent” of which the formula has been published by Mr. Perry Coste (B. M. J., ii., 1901). Calcium salts may relieve vesical pain and inflammation, and by a constringing and sedative effect on the mucous membrane of the bladder may lessen the ropy discharge and the general sensibility; a solvent action may also be exerted, but not probably to a great degree; the benzoate of calcium has been credited with more decided effect. Lime-water should also be injected, after washing out the viscus with soothing mucilaginous liquids. Professor Stillé remarks: “There is reason to believe that uric acid gravel may be dissolved and eliminated under the use of lime compounds. How far they are superior to the carbonate of the alkalies for this purpose will depend chiefly on the state of the digestive organs—when these are feeble, lime-water is the better preparation.”

The waters of Wildungen, which are much used in lithiasis, owe their efficacy principally to calcium carbonate: Vittel and Contrexéville have more sulphate.

Albuminuria.—On account of the power of calcium salts to dissolve organic membranes, they have been recommended in chronic Bright’s disease, and in post-scarlatinal albuminuria “to dissolve proteinous infiltrations of the kidney.” Kuchenmeister reports cases treated by large doses of lime-water and soluble calcium salts, with immediate and marked increase in the quantity

of urine passed, and with corresponding subsidence of the dropsy. The amount of albumin was lessened, but sometimes slight hæmorrhage occurred (Ranking, 1869; Rev. Méd., 1870).

From our knowledge of the styptic properties of calcium salts, we should expect them to restrain renal hæmorrhage rather than to cause it, and Stromeyer and Caspari report the value of the phosphate for this purpose.

PREPARATIONS AND DOSE.—*Liquor calcis*: dose, 1 to 4 fl. oz. or more (contains $\frac{1}{2}$ gr. to the ounce). *Liquor calcis saccharatus*: dose, 20 min. to 1 fl. dr. (contains 7·11 gr. to the ounce). *Liquor calcis chlorinatæ* (not given internally). *Linimentum calcis* (lime-water and olive oil, equal parts). *Creta præparata*: dose, 10 to 60 gr. *Mistura cretæ*: dose, $\frac{1}{2}$ to 1 fl. oz. (contains chalk $\frac{1}{4}$ oz., gum acacia $\frac{1}{4}$ oz., syrup $\frac{1}{2}$ oz., cinnamon water to 8 oz.). *Pulvis cretæ aromaticus*: dose, 10 to 60 gr. (contains cinnamon, nutmeg, saffron, cloves, chalk, cardamoms, sugar). *Pulvis cretæ aromaticus c. opio*: dose, 10 to 40 gr. (contains 1 gr. of pulv. opii in 40). *Calcii chloridum*: dose, 5 to 15 gr. and upwards (may be given in pill, with syrup or in milk). *Calcii phosphas*: dose, 5 to 15 gr. or more. *Calcii hypophosphis*: dose, 3 to 10 gr. *Calcii carbonas præcipitatus*: dose, 10 to 60 gr. *Calcii phosphas*: dose, 5 to 15 gr. *Syrupus calcii lactophosphatis* (with lactic and phosphoric acids): dose, $\frac{1}{2}$ to 1 dr. *Calx sulphurata*: dose, $\frac{1}{4}$ to 1 gr. Besides these preparations, there are many compounds such as the iodide and bromide, permanganate and salicylate of calcium of which the lime is the less active ingredient, and of which the properties are mainly those of iodine, bromine, etc. A number of formulæ for lime sucrates, hypophosphites, etc., are given in the Pharm. Journ., June, 1877.

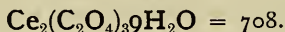
Of saccharated wheat phosphates the dose is from $\frac{1}{2}$ dr. and upwards with food. Various formulæ for “phosphated bread” and natural forms of phosphate have been published. Superphosphate of calcium, $\frac{1}{2}$ oz.; carbonate of iron, $\frac{1}{2}$ oz.; butter and sugar, of each $\frac{1}{4}$ lb.; flour, $\frac{3}{4}$ lb.; treacle, $\frac{1}{2}$ lb.; make 80 cakes (Med. Times, i., 1859). Acid phosphate of calcium and moist carbonate of sodium may be used as a good “baking powder” (Horsford, Ranking, ii., 1860). Chevrier has an aerated water containing tribasic phosphate (Pharm. Journ., Sept., 1874). Dannecy recommends to wash and powder beef bones, and boil them for an hour with carbonate of sodium and water, then to wash in a filter—to dry and sieve (Bull. de Thérap., 1858).

CERIUM, Ce = 141 (139·20). (Not official.)

This metal, which is not a common one, was discovered by Berzelius in a Swedish ore called cerite or heavy-stone—a silicate of iron, calcium, lanthanum, didymium and cerium, which last is

obtained from it in the form of a grey metallic powder: oxalic acid is used in the process, and hence oxalate of cerium is the best-known commercial salt: it is the only one official.

CERII OXALAS—CERIUM OXALATE



CHARACTERS AND TESTS.—A white granular powder, which when heated to redness gives a reddish-brown residue of impure oxide, soluble in boiling hydrochloric acid without effervescence; this solution gives with sulphate of potassium a white double sulphate of potassium and cerium: the oxalate itself is insoluble in water; it usually contains some oxalate of lanthanum, and oxalate of didymium. The soluble salts, such as the chloride and nitrate, have a sweet astringent taste; with alkalies and their carbonates they give yellowish-white precipitates.

PHYSIOLOGICAL ACTION.—*Internal.*—There is some clinical evidence in favour of attributing to cerium a sedative action upon the gastric mucous membrane and upon the nervous system, and especially on reflex excitability. Dr. C. K. Mills could obtain no evidence of its absorption (*Phil. Med. Times*, 1876).

SYNERGISTS.—Bismuth, silver, and cyanides.

THERAPEUTICAL ACTION.—*Internal.*—**Vomiting, etc.**—Sir J. Simpson introduced the oxalate of cerium “as a sedative tonic resembling bismuth and silver,” valuable in irritative dyspepsia and vomiting, especially when reflex, or dependent on pregnancy (*Edin. Month. Journ.*, 1854; *Med. Times*, 1855-59). He calls it “the simplest and surest remedy,” with which he has cured more cases than with any other medicine, and records several illustrations of its prompt and effective action when ordinary treatment had failed: he gave 1 to 2 gr. doses in pill. Drs. Lee and Curran have recorded similar experience, but the latter rather confused his results by giving bromide and bark at the same time. Mills found that the nausea and vomiting of pregnancy almost always yielded promptly to a few doses: of eleven cases reported, ten were relieved permanently, one only for a time (*loc. cit.*). Similar symptoms associated with dysmenorrhœa, flexion and other uterine disorders, and with hysteria from anxiety, grief, overwork and the like, were also relieved by cerium. Obstinate vomiting occurring in the course of phthisis

and during typhoid fever was successfully treated by 2 to 3 gr. doses (Med. Record, 1876). The amount of published evidence as to the general use of the drug is meagre, but I have myself often obtained excellent results from it. Dr. Image attributed occasional disappointment to the use of too small doses, recommending 10 gr. with tragacanth, tincture of orange and water every four hours, the first dose being taken half an hour before rising. He quotes a case in which vomiting always had commenced in the fourth week of pregnancy and lasted till the eighth month, but with this remedy the attacks, though recurring at intervals, were invariably checked in two or three days, and of a great many cases of pregnancy with vomiting not a single one was unrelieved by the same treatment (Pract., 1878). I have not required to use so large a dose, but it should certainly be tried if smaller ones fail. Dr. Busey has recommended oxalate of cerium to obviate the nausea and headache produced in some persons by opium, just as Da Costa prescribed bromide, and others coffee; it has the advantage of small bulk and of tastelessness (Pract., 1879).

Dyspepsia.—Gastrodynia, etc.—Sir James Y. Simpson recommended the oxalate in primary as well as in reflex gastric disorder, and Dr. C. Lee has given instances of its value in pyrosis, in phthical and atonic dyspepsia; it may be used in the class of cases in which bismuth is indicated. Dr. Mills found it act best when morbid reflex influences were a main cause of the indigestion, and depressed or deranged innervation of the stomach existed: in diarrhoea from nervous irritation, cerium was also successful; “it seems to have the power of diminishing reflex excitability of the alimentary tract”; in dysentery, gastric ulcer, cancer and gastro-enteritis, he tried the medicine, but with less satisfactory result.

“Chronic Cough.”—Mr. Clark has recorded cases of chronic pulmonary disorders with partial consolidation, and accompanied with dyspnoea on exertion and violent *morning cough* producing sickness, the symptoms of which were much relieved by the sedative effect of oxalate of cerium, given in 5 gr. doses half an hour before rising (Pract., 1878).

PREPARATION AND DOSE.—*Cerii oxalas*: dose, 2 to 10 gr. For an infant or child under two years, $\frac{1}{4}$ to $\frac{1}{2}$ gr.

COBALT, Co = 58.9. (*Not official.*)

This is a reddish-white, tenacious and strongly magnetic metal of sp. gr. 8.5. It occurs in nature in combination with arsenic and sulphur.

PHYSIOLOGICAL ACTION.—The most complete study of the action of cobalt has been made by Anderson Stuart (*Journ. of Anat. and Phys.*, xvii., 1883), working in Schmiedeberg's laboratory. He used a double salt of the metal which did not precipitate albumin, and hence could be injected directly into the blood without causing clots, or could be given by the stomach or subcutaneously without vomiting or irritation. (Previously little was known of its action, except that large doses caused such symptoms (Gmelin).)

In frogs it caused twitching of the muscles, increase of reflex excitability and tetanus, followed by muscular and nervous depression. In cats and dogs toxic doses given subcutaneously or intravenously induced severe diarrhoea, vomiting, and tetanic convulsions, with intervals of great depression. The nervous system became greatly exhausted, respiration failed and death ensued in a final convulsion, or quietly; the heart went on beating for some minutes after death; on examination the intestinal canal was always found covered with extravasated blood.

In chronic poisoning, vomiting, serous diarrhoea, severe stomatitis, and increased reflex excitability were the prominent symptoms; the urine was coloured brown. The blood pressure falls, not from cardiac failure, but from dilatation of the blood-vessels. The action of cobalt is, therefore, almost, if not quite, identical with that of nickel. In both cases the greatly increased spinal reflex is the prominent feature of poisoning. It must be remembered that these results were obtained with large doses, and there is no reason to suppose that the administration of small doses of a double salt by the mouth (say $\frac{1}{4}$ to $\frac{1}{2}$ gr.) would have deleterious effects. Stuart's double salt did not act as a poison either to striped muscle or to the blood corpuscles. Excretion of cobalt takes place from the blood into the bowel when it is given hypodermically.

THERAPEUTICAL USES.—These are at present practically nil. Small doses have been used as a substitute for iron in anæmia but without beneficial result.

CUPRUM—COPPER, $\text{Cu} = 63\cdot4$ ($63\cdot12$).

The metal (which derives its name from Cyprus) is now obtained chiefly from the mines of Cornwall, of the Pyrenees, and of Fahlun in Sweden, in the form of a double sulphide with iron (copper pyrites, Cu_2S , Fe_2S_3): an oxide, a sub- or red oxide (cuprite), and an oxycarbonate (malachite) also occur, as well as arsenates, phosphates, etc.

The official metal consists of fine wire about No. 25 gauge, or about 0·02 inch; it is used in the preparation of the nitrate and sulphate, and of spiritus ætheris nitrosi. Copper foil is placed in the appendix of the Pharmacopœia as a test: it forms cuprous and cupric salts, *tests* for which may be remembered by their colour, as (1) *the red test*, shown by immersing clean iron in an acid solution of copper, when the red metal will be deposited; (2) *the blue test*, shown by the coloration produced with excess of ammonia; (3) *the brown test*, by the bulky reddish-brown precipitate which occurs with ferrocyanide of potassium. An alkaline solution of the sulphate (Fehling's) is used as a test for glucose, which precipitates from it the oxide of copper on boiling.

CUPRI SULPHAS — COPPER SULPHATE — BLUE VITRIOL —COPPERAS, OR BLUE-STONE ($\text{CuSO}_4\cdot5\text{H}_2\text{O} = 249\cdot4$).

CHARACTERS AND TESTS.—It occurs in oblique prisms of deep-blue colour and metallic styptic taste; soluble in 4 parts of cold, and 2 of boiling water, insoluble in alcohol, efflorescing slightly in dry air; its aqueous solution is blue, and reddens litmus strongly. The anhydrous salt is *yellowish white*, but turns *blue* when moistened with water, and hence serves as a test for the presence of water in absolute alcohol. The sulphate answers to the tests for copper already given, and like other sulphates gives a white precipitate of sulphate of barium with barium chloride.

Ammonio-Sulphate of Copper in solution is used as a test for the presence of sulphides in liquor ammoniæ fortis, and also as a test for arsenious acid, with which it produces a light-green precipitate of arsenite of copper (Scheele's green).

ABSORPTION AND ELIMINATION.—Metallic copper, even when powdered, is not usually absorbed. Drouard gave large doses to animals without any result (Paris, 1802), but when finely divided some may be rendered soluble by the gastric acids, and traces may be detected in the urine and saliva (Mialhe, Mitscherlich, Portal). Copper coins have often been swallowed with impunity, but profuse salivation is recorded in the case of a child after swallowing a penny (Barton, quoted by Gubler). That the sulphate can be absorbed from wounds has been both affirmed and denied. Langenbeck and Städelér have traced poisonous symptoms to this cause only when fatty acids were present, but such absorption, though it may occur, is certainly not frequent. Workers with alloys or salts of copper are said to absorb it, for their secretions, hair and teeth may be coloured green during life; it has been found in their urine, and after death in the bones, and even in the earth in which they were buried (Millon, Bull. Acad. Méd., t. xii.). (It has been asserted and is now generally believed that these discolorations are due simply to external deposits of copper, which form green salts with the fatty acids of the skin, etc.) Soluble salts of copper combine with albuminous secretions and form a bluish coagulum; this, when resulting from a salt of an organic acid (as the acetate), is still soluble, but from a salt of a mineral acid (as the sulphate) it is more resistant (Mitscherlich). In any case, only a portion of even a moderate dose is absorbed into the blood, and this probably as an albuminate—the larger portion passes off by the bowel, and appears in the dark-brown fæces as sulphate.

Elimination occurs by the bile, the saliva and bronchial secretion (Flandrin and Danger, Annales de Thérap., vol. i.): these observers did not detect it in the urine, but others have done so. Elimination is *slow*, for Orfila found copper in the viscera seventy days after its use had been omitted. It is apt to be deposited in the liver especially. Ellenberger and Hofmeister found it eliminated in bile and urine, with liability to deposit in the liver and pancreas, but not showing cumulative effects like lead (Med. Record, 1884).

It must be recognised as a very usual constituent of the normal organism. Sargeaux detected it in the blood of many

animals, and Odling and Taylor in the liver, kidneys and other organs, irrespective of poisoning (Guy's Reports, 1866). In the bodies of domestic animals fed on vegetable food Wackenroder found no perceptible amount of copper, but in snails and shell-fish comparatively much; in man and carnivorous animals he found also a rather large proportion both of copper and lead, and concluded that they were derived from the nutritive or medicinal substances taken (Brit. For. Rev., 1855). Fredericq has found that the blue pigment of the blood of crustaceous cephalopods, and other invertebrate animals is an albuminous substance which contains copper; this substance fulfils the function in respiration which is carried out by hæmoglobin in vertebrate animals, and copper here seems to take the place of the iron in hæmoglobin. Odling and Dupré found copper in bread, flour, shell-fish, etc., and in the human liver and kidneys not invariably, but usually (Guy's Reports, 1858). Stevenson remarked that copper might be derived in the course of an analysis from a copper lamp used for incineration, so that the greatest care is required in such investigations (Lancet, ii., 1872). Schwartzbach found 0.004 gramme of copper and rather more lead in 2,100 grammes of liver (Brit. For. Rev., 1857); Orfila had reported ten times as much. More recently, the average amount found in the entire liver and kidneys in fourteen bodies was 2 to 3 milligrammes ($\frac{1}{3}$ to $\frac{1}{2}$ gr.), and it was found also in the foetus. The specimens used in the investigation were carefully chosen as not having been exposed to absorption of copper, and the metal was excluded from all apparatus employed. We may therefore conclude that any quantity above 4 milligrammes ($\frac{1}{16}$ gr.) found in these organs is abnormal, and results from direct administration of the drug (Lancet, i., 1875). In the case of the two wives of Moreau, 120 milligrammes and 80 milligrammes were found respectively (B. M. J., ii., 1874, and i., 1875). In a case where ammonio-sulphate of copper had been taken three months before death, nearly 300 milligrammes ($4\frac{1}{2}$ gr.) were obtained from the liver, a good instance of its slow elimination (Rev. Scientifique, 1874). Rabuteau found 16 centigrammes ($2\frac{2}{3}$ gr.) in 1,000 grammes of liver also three months after the last dose—43 grammes in all of ammonio-sulphate had been taken (Gaz. Hebdom., 1877).

PHYSIOLOGICAL ACTION. — *External.* — The sulphate,

which is the salt most commonly used, has little action on the sound skin, but when applied to wounds or mucous membranes coagulates the albumin, and forms a thin film on the surface. The pure salt or its concentrated solution acts as a caustic; weaker solutions act as stimulants and astringents, both forms producing more or less condensation of the neighbouring tissues. They exert also some antiseptic power, partly by decomposing sulphuretted hydrogen, and partly by destroying low organisms, whether animal or vegetable. Any conclusions drawn from the effects of the smoke and vapours of copper foundries are rendered doubtful by the co-existence of sulphurous acid, arsenic, etc. Vegetable life of all kinds is destroyed in the immediate neighbourhood of such works. A solution of copper sulphate has been recommended as a cheap and useful disinfectant for washing the floors of sick rooms; it impregnates the boards, and thus renders them uninhabitable for germs of disease (Med. Press, i., 1883).

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—In the lower animals, salts of copper seem to be uncertain in their effects, at least when given by the mouth. According to Orfila, vomiting is the earliest and most marked symptom, and Drouard found that 12 gr. of sulphate caused fatal gastric inflammation in dogs. On the other hand, Galippe could not poison dogs with pure copper salts, for small doses were tolerated, and large ones were so nauseous that he could not get enough swallowed or retained (Bull. de Thérap., 1875). Ducoin and Burq reported that dogs could take from 15 to 60 gr. daily of soluble salts of copper for a varying time without ill effect on the general condition, with the exception of vomiting at first; long-continuance of this medication at length impaired appetite and digestion, and thus led to death from exhaustion (*ib.*).

In man, small doses ($\frac{1}{4}$ gr.) of a soluble salt of copper exert a tonic astringent action, but if continued for a long time impair appetite and digestion, and cause diarrhoea from irritation. The effects of frequently repeated minute doses have excited special attention, on account of the adulteration with copper of many preserved vegetables. Thus, in the French preserved *green peas*, 0.31 to 0.56 gr. has been found in each tin, and by some chemists, and medical men, this quantity has been

pronounced injurious (B. M. J., 1876-77). In a case tried at Glasgow, 1.54 gr. of copper sulphate was found in each pound of peas (*ib.*, 1890), and continued to be found (Lancet, i., 1898; i., 1900).¹ Vulpian, however, says that any copper compound contained is insoluble and harmless, and that no evidence exists to the contrary; and Galippe, after the crucial test of eating them freely for some time and also having all his food cooked in copper vessels, found no bad result (B. M. J., 1877): but I have no doubt that they often cause indigestion. In a 4 lb. loaf of bread .4 to 1.8 gr. has been found, and the latter amount might become serious (Med. Times, i., 1871). Gautier calculates that a man's daily food in France contains $\frac{1}{60}$ gr., more if he takes freely preserved green vegetables or chocolate ("Le cuivre et le plomb"). Doses of 1 to 3 gr. induce a sense of constriction in the gullet, and vomiting occurs in a few minutes without much nausea, and is commonly attended with diarrhœa; 5 to 15 gr. act as a powerful irritant emetic.

Sir Lauder Brunton and Dr. West have experimented to ascertain whether cupric salts cause vomiting by irritation of the stomach, or of the vomiting centre in the medulla. Into the jugular vein of cats they injected a neutral albuminate of copper (which would not cause coagulation of blood), and retching and vomiting followed. Previous section of the vagi did not prevent the retching, but it did prevent evacuation of the stomach, and after section of the vagi and the splanchnic nerves neither retching nor vomiting occurred: hence they conclude that these symptoms depend upon gastro-intestinal irritation, not upon a direct excitement of the central organs (Barth. Hosp. Rep., 1876).

Toxic Action.—Half an ounce of sulphate given at one time by the mouth produces severe symptoms of irritant poisoning, including metallic taste, feeling of constriction, thirst, salivation, nausea, vomiting, purging, and severe cramping pain with tenesmus; the abdomen is distended and tender, the evacuations greenish or containing blood; the face may be flushed and swollen, the gums ulcerated, and sometimes jaundice occurs; death may follow from enteritis or exhaustion within a few hours or days. From 1 to 2 oz. of sulphate or acetate may be reckoned a fatal dose, though recovery has occurred after 5 oz., when vomiting

¹ Prosecutions on the subject continue (1903).

has been free (Toussaint and others); in practice a fatal issue is rare. Dr. Dumoulin states that he has given large doses continuously to animals without ill effects, and has in the treatment of scrofula and croup given as much as 40 gr. in a few hours to patients, without any but good results (Semaine Médicale, ii., 1885).

Blandet asserts that *enteritis*, though commonly produced by carbonate or acetate of copper, does not occur from the sulphate, and in one case where 300 gr. were taken, vomiting, suppression of urine, and subsultus occurred, yet recovery took place without enteritis (Med. Times, i., 1874); the danger of the drug has doubtless been exaggerated, and Hönerkopf gave in seventy-two cases 5 grammes, and in eighteen cases nearly 3 grammes, without injury, but in other cases enteritis has been caused.

Acute copper poisoning occurs most often from accidental contamination of food cooked in copper vessels, which when perfectly clean and pure are not harmful, but under the influence of air and moisture, vinegar, salt, or hot fats,—carbonate, acetate, and oxychlorides of copper are formed, and the admixture of these salts ("verdigris") with the food is exceedingly injurious, causing severe colic, vomiting, headache and pyrexia; tympanites is sometimes very marked, and numbness and tremor of the limbs have been noted (Med. Times, 1844). Similar symptoms, with scanty urine and excoriations about the mouth followed the use of water boiled in a copper kettle, and of injections from a brass syringe (Amyot, Med. Times, i., 1859; Boggs, Lancet, ii., 1869). An epidemic much resembling dysentery occurred on board an Indian emigrant ship from using copper for the cooking of rice with ghee or butter (Moore, Lancet, i., 1846). If only one portion of the contaminated food has been taken, recovery is usually rapid and complete in proportion to the amount of vomiting; but if more be taken and not rejected, there remains a tendency to colic, vomiting or diarrhœa, with much debility. Should death follow, there will be found intense redness of the intestinal tract or actual ulceration, according to the stage of the poisoning; perforation is rare.

Chronic copper poisoning—"Cuprismus chronicus."—Whilst by some observers this condition has been described as marked and frequent, by others its existence has been denied, and the symptoms explained by adulteration with lead, or other metals.

The truth lies between extreme views—some amount of copper poisoning may be traced amongst workers with the metal, but it is not very serious. Working in pure metallic copper without heat causes no bad symptoms (Hirt, Maisonneuve), but particles of oxide and cupric salts in the air of heated rooms may induce dyspnœa and laryngeal spasm. “Gold printers,” working with brass alloy in fine powder, sometimes get vomiting, gastric pain, and anæmia; the hair becomes green-coloured (Taylor). Dr. G. Harley has described a case of sudden colic with nausea, but neither diarrhœa nor constipation, in a copper-plate printer after cleaning plates coated with verdigris: there was a purple line on the gums (Lancet, ii., 1863). Blandet was the first to describe a more serious chronic *cuprismus* as existent in Paris workshops, and marked, besides the green coloration, by colic with remissions, fever, lassitude, nausea, bilious vomiting and diarrhœa, alternating with constipation (Gaz. Méd., 1845). Mr. H. H. Latimer, surgeon to the Swansea Copper Works, describes what he calls “Copper-man’s chest” as a fibrosis of the lung; the most marked symptom is dyspnœa, with asthmatic exacerbations; this is associated with cardiac irregularity (Lancet, i., 1887). A light or reddish-purple line on the margin of the gums is described as characteristic, but really indicates an *inflammatory* condition which may arise from other causes (Bucquoy, Union Méd., i., 1874). Bailly describes the true copper bluish-green or blue line as on the *teeth* only, not on the gum, which, however, was commonly inflamed: by analysis he detected copper in the blue line. Perron reported the prevalence of dyspepsia, “enteritis,” and phthisis, amongst Swiss watchmakers working with an alloy of gold and copper; they had green coloration of the teeth, but mal-hygiene was a more likely explanation of their impaired health (Med. Times, ii., 1861). Dr. Clapton brought before the Clinical Society cases of irritative dyspepsia in a flower-girl and a coppersmith, but his inquiries about copper-workers verified the absence of any special disease amongst them (Transactions, vol. iii.). Chevallier, after an exhaustive inquiry, concluded Blandet’s statement to be exaggerated, and failed to verify a true “copper colic” (Annales d’Hygiène, 1859); any severe cases were found complicated by the presence of lead in the material used. Christison and Chomel reached the same

conclusion. Hirt, whilst allowing that verdigris-makers may suffer from intestinal catarrh, and even from some amount of paralysis, blames rather lead, zinc, or arsenic in observed cases of severe "colic". I have known brass-founders get periodic attacks of colic and vomiting followed by rigors—a condition known in the workshops as "brass-founders' ague," and induced when the alloy is melted and they are much exposed to its vapour—but have connected it rather with zinc or arsenic than copper. Pécholier and Pietra Santa, reporting on the health of verdigris-workers, describe local irritation of mucous membranes, but otherwise good health: they note especially the absence of colic and of chlorosis (*Med. Times*, i., 1864); and Maisonneuve concluded that though gastro-intestinal disorder may be induced by such work, the symptoms are neither severe nor persistent (*Ranking*, i., 1865). Any harmful effects cannot be compared with those of lead in severity.

Pathological Changes.—In animals that had taken copper for a long time, Mair observed softening and degeneration of the liver, and in one case of poisoning by the sulphate Maschka attributed the jaundice to fatty degeneration; the kidneys were similarly affected (*Syd. Soc. Year Book*, 1873).

Neuro-Muscular System.—If a solution of tartrate of copper and sodium (equal to $\frac{1}{2}$ gr. of oxide of copper) be injected under the skin of a rabbit, there will quickly follow unsteadiness in walking, which will gradually pass into complete motor paralysis: the respirations and pulse become feeble, and muscular irritability becomes less, till finally death occurs from paralysis of the respiratory muscles (*Harnack, Archiv f. expt. Path.*, iii.). Falck noted very similar effects, with fall of temperature and progressive general paresis ending in death from cardiac palsy, after hypodermic injection of sulphate, nitrate, and chlorate of copper (*Deutsche Klinik*, 1859); sensation was unimpaired, and the paralysis was limited to transversely striated muscular tissue. Harnack has since shown that small doses of copper salts exert a preliminary stimulating effect on the frog's heart; no such action has, however, been demonstrated in mammals (*op. cit.*, ix.), although they have been credited with a stimulant effect on the tissues and with the power of increasing the tone of muscle (*T. Oliver*).

It has been remarked that many *emetic* medicines, *e.g.*, antimony and apomorphine, produce also muscular paralysis, and there may be some direct connection between it and severe vomiting: in Falck's experiments, however (with hypodermic injections), vomiting was not produced. In cases of acute copper poisoning in men, the nervous symptoms are such as headache, giddiness, prostration, restlessness, tremor, subsultus tendinum, convulsions alternating with stupor or comparative clearness of mind, and sometimes a motor or sensory palsy, partial and temporary in character: such symptoms are mainly secondary to the gastric irritation.

Respiratory and Other Systems.—In the course of acute poisoning, respiration becomes hurried and laboured, the pulse small and usually quickened, and the extremities cold; suppression of urine has been recorded, but amongst workers in copper absorbing slight amounts daily, *diuresis* was a usual symptom (Clapton).

SYNERGISTS.—Salts of lead, zinc, silver and gold, are allied in action to those of copper. Depressing vital conditions favour the development of their irritant properties.

ANTAGONISTS.—INCOMPATIBLES.—Metallic sulphides, alkalis and alkaline earths, iodides, and vegetable infusions containing tannin, are chemically incompatible with salts of copper: a boiling solution of certain forms of sugar, like grape sugar, also reduces them. In cases of poisoning the action of sugar seems to be useless because too slow, and magnesia, though it may retard bad effects, does not wholly prevent them, since the hydrated oxide of copper is soluble. Sulphide of iron decomposes copper salts (forming an insoluble cupric sulphide), and may be used as an antidote. Albumin, which may be given in the form of egg and milk, forms an albuminate of copper, but this is not inert and should be removed afterwards by the stomach-pump (Schroeder).

THERAPEUTICAL ACTION.—*External.*—Applied in lotion, ointment, powder or crystal, sulphate of copper, "blue-stone," or "blue-vitriol," acts as a stimulating astringent, or a moderately severe caustic. It unites with albuminous secretions to form an insoluble albuminate of copper, which, acting like a new cuticle, protects the injured part from the atmosphere, and promotes the

healing process. Equal parts of sulphate of copper, alum and nitre, fused with four parts of camphor, form a caustic known as "*lapis divinus*," or green-stone.

Tinea Tarsi.—Trachoma.—In these chronic, recurrent disorders of the eye-lashes and lids, crusts and muco-purulent discharge, and in severe cases the lashes, should be carefully removed, and a crystal of copper sulphate lightly applied to the affected parts. In trachoma the lid should be everted, and the blue-stone applied to each little new growth separately. This treatment has the recommendation of Sir W. Wilde, Galezowski, and other authorities, and Mr. Williams (Boston) has published good practical instructions concerning it (*Ranking*, ii., 1870). I prefer this remedy to either zinc or silver, since it is milder and causes less pain; I generally combine with it the use of a dilute mercurial ointment.

An improvement upon the use of copper alone seems to be the subsequent application of a rod of metallic zinc, which further tends to destroy granulations by the galvanic reaction excited (*Rec.*, 1884).

Aphthous Stomatitis.—Sulphate of copper, either applied lightly in substance, or brushed over the affected part in strong solution, removes the white curdy deposit and induces healing of abrasions and ulcerations about the gums: 10 gr. mixed with about 1 oz. of honey is a good form for its use in children. Sir James Paget recommended a gargle containing 1 to 2 gr. of sulphate in 1 oz. of water, as useful in salivation,—free purging being secured at the same time (*Med. Times*, i., 1858); a similar lotion will destroy diphtherial membrane.

Indolent Ulcer.—Rectal Ulceration.—The solid crystal of the sulphate is a good stimulant to indolent ulcers, and a good caustic for exuberant granulations. The nitrate acts similarly to the sulphate, but is a more powerful caustic and styptic; it is specially useful as a local application to syphilitic sores on the tongue. Dissolved and used as an injection it is of service in various forms of ulceration affecting the rectum, especially, according to Mr. Christopher Heath's experience, in the later syphilitic forms, when the dorsal surface, or sometimes the whole circumference of the bowel within two inches of the anus, is affected, and there is much muco-purulent discharge. For such cases Mr. Heath recom-

mends an injection containing about 10 gr. of sulphate to the pint, a fourth part to be used at one time and retained for ten minutes : this has an excellent astringent effect, and should be combined with the use of mercurial ointments locally, and iodides internally (Lancet, i., 1873).

Hæmorrhage.—It is used as a styptic to arrest the flow of blood from leech-bites. In solution it may be employed as an injection to stop epistaxis.

Cancer.—The arsenite of copper (Scheele's green) is said to be a valuable application for cancerous sores. Mr. Taylor (Liverpool) used it with an equal part of mucilage, and found it a good escharotic, disinfectant, and at the same time sedative dressing (Lancet, ii., 1864); it has not, however, been much used.

Skin Diseases.—In parasitic cases, such as ringworm and scabies, the sulphate of copper has been applied with success : in the former Dr. Graves recommended a wash containing 10 gr. to the ounce, a strength which may, with advantage, be doubled. The oleate of copper in about 10 per cent. dilution has been commended by some for ringworm, but I have not found it superior to other and better known remedies and the green colour may be an objection. Dr. Crocker has recently reported it of service when epilation is necessary, since it has a loosening effect upon the hairs, so that many could be removed entire and with little pain (B. M. J., ii., 1893). He uses an ointment 1 part in 8, or even 1 in 4, following Shoemaker, and finds this often effective, but for some cases too irritant. An ointment containing a similar proportion mixed with lard has cured scabies (Lancet, i., 1846). In ichthyosis this ointment has also been recommended by Mr. E. Wilson, and the solid crystal is often used for verruca and molluscum. Small doses have been given like arsenic in scaly dermatoses.

Gonorrhœa.—Leucorrhœa.—Gleet.—In these disorders an injection containing sulphate of copper, 1 to 2 gr. in the ounce, is often a useful alternative to injections of zinc or lead, or it may be combined especially with the acetate of lead. Dewees and also Diday have shown the value of cupric injections in such cases (Archives Gén., xviii.), and Dr. P. Foster has illustrated the same (Med. Times, ii., 1873). In balanitis a copper lotion is useful.

M. Charpentier considers that a 1 per cent. solution of copper sulphate is quite as efficacious and much safer than the *Liquor Ferri perchloridi fortis* for intra uterine injection in hæmorrhage (B. M. J., i., 1884).

Bubo, etc.—Good results have been obtained after surgical evacuation of a suppurating bubo, from injecting a weak solution of copper sulphate into the cavity. M. Danielli found this quickly diminish the secretion, which after simple opening is very apt to re-form (Bull. de Thérap., 1868). M. Diday recommended a strength of 3 gr. to the ounce. The solid sulphate is a good application to syphilitic cracks, patches and ulceration about the mouth and tongue.

Hydrocele.—As an injection for hydrocele, 2 to 8 parts of sulphate in 200 to 250 of water has been used with success. Dr. Pereira (Oporto) states that twenty-one out of twenty-five cases were cured with this treatment (Med. Times, i., 1866).

Caries.—Fistulous Tracts.—Strong stimulating and astringent lotions are sometimes of service in these conditions, especially after the carious bone has been removed, or the fistula divided. The "*liquor Villati*" has been much used abroad in such cases without previous operation; it is made with $\frac{1}{2}$ oz. of sulphate of copper and of zinc, and 1 oz. of lead subacetate, dissolved in 7 oz. of vinegar; M. Notta and M. Nélaton have used this with advantage, but it is painful, and should not be injected more than two or three times a week (Union Méd., 1866).

THERAPEUTICAL ACTION.—*Internal.*—In small doses the salts of copper exert a tonic influence upon the nervous system, and an astringent effect on mucous membranes, whilst doses of 5 to 10 gr. are emetic. The salts in question resemble in action those of zinc, but are more irritant.

Chorea.—Although preparations of copper are not now much used in this affection, I can refer to some very good results from the sulphate in my own experience, and especially in cases connected with tænia and other intestinal worms. I think it well worthy of use in cases where there is even a suspicion of their existence; it will aid their expulsion if present, and in any case act as a good nervine tonic. I have seen apparently good results from $\frac{1}{4}$ gr. given three times daily, though the natural tendency of chorea to recover must not be forgotten.

Hysteria.—In some cases of hysteria, with general debility, shyness, muscular twitching, etc., marked benefit may be derived from the same treatment.

Epilepsy.—It is probable that of the older cases called epilepsy and reported as cured by copper, a large proportion were hysterical, but Voisin reports from the practice of Herpin (Geneva) several illustrations of its power to apparently cure chronic and obstinate cases of true epilepsy. He generally used the ammonio-sulphate alone or alternately with zinc, for many months; the cure continued permanent some years afterwards (*Bull. de Thérap.*, i., 1870). Halford made great use of copper combined with quinine in this malady (*Med. Times*, i., 1858), but general experience is not in its favour. Charcot has published a case carefully treated for three months with full doses of the ammonio-sulphate, but the convulsive attacks were rather increased during its use (*B. M. J.*, i., 1875). I have given the sulphate and the acetate in varying doses and for long periods in many cases, but have not seen benefit from them in idiopathic epilepsy, although for epileptiform attacks associated with intestinal worms they have several times proved useful.

Spasmodic Asthma.—In cases where there occur well-marked paroxysms, terminating in the ejection of quantities of mucus, small doses of sulphate of copper, repeated frequently until vomiting occurs, will usually give relief; but independently of vomiting, in asthma of more purely nervous type, I have observed benefit from $\frac{1}{6}$ gr. and upwards, given every one to three hours during the attacks, and continued night and morning in the intervals, so as to secure a tonic effect on the nervous system.

Tapeworm.—I have often known tæniæ dislodged and passed under the use of small doses of the sulphate; about $\frac{1}{6}$ gr. in solution is a suitable amount to commence with, and may be given every morning, fasting. If this dose be steadily and gradually increased, upwards of 3 to 5 gr. may be administered without causing vomiting or purging; but should these symptoms occur, the medicine is better omitted for the time, to be resumed in smaller doses if again required. This treatment should be continued for eight to ten days or longer, an occasional dose of castor oil being given.

Chronic Diarrhœa and Dysentery.—Sulphate of copper is an excellent remedy in these disorders, given in doses of $\frac{1}{2}$ to 1 gr., three or four times daily, but I have known it sometimes increase irritation and pain. Elliotson recommended somewhat larger doses, and generally combined with opium in a pill (Med.-Chir. Trans., vol. xiii.); but if opium be really required for pain, I find it better given separately, especially in the form of Dover's powder at bed-time. Morehead also recommends this treatment (Diseases of India, i.). In *infantile* diarrhœa, objection has been taken to the use of copper, but I have seen it act most beneficially in obstinate cases, not only when chronic, but also when acute in character, and especially when connected with dentition—the dose may vary from $\frac{1}{20}$ to $\frac{1}{4}$ gr. several times daily. Pereira specially recommends the remedy in $\frac{1}{12}$ gr. dose. Eisenmann has also recorded its value in the diarrhœa of dentition and of weaning, and states that he has seen many cases treated by it and cured, when others, not so treated, have become chronic and ended in marasmus (Bulletin, 1859). For these and other forms of intestinal disorder the arsenite of copper in small frequent doses,— $\frac{1}{5000}$ to $\frac{1}{3000}$ grain, every 10 minutes for 6 doses, then hourly,—has been given with benefit; for children half this dose.

In chlorotic anæmia $\frac{1}{100}$ to $\frac{1}{25}$ grain may be given three times daily (Thérapi. Gaz., 1889-1892; B. M. J., i., ii., 1890).

In the *diarrhœa of phthisis*, dependent as it commonly is on ulceration of the intestine, we often require to use different forms of astringents, and the sulphate of copper is a valuable alternative. Small doses only should be used, in order to avoid nausea and irritation— $\frac{1}{4}$ gr. with the same quantity of opium is advised by Sir T. Watson (Lectures), even this sometimes causes pain. The acetate of copper is said to be useful for the general symptoms of advanced phthisis, lessening sweating, pyrexia and cough (Record, 1886).

In **Enteric Fever** with severe diarrhœa the sulphate in $\frac{1}{4}$ gr. doses in pill every two to four hours is highly praised by Dr. John Harley (Reynolds' System, i.), who "considers it more efficacious than any other medicine." The dose may be increased up to 1 gr., but must be kept small enough to avoid vomiting; quite small doses rather allay gastric irritability.

Cholera.—In this malady the sulphate has been considered by some physicians almost a specific. I cannot place great reliance upon it, though I have sometimes observed it relieve the cramps, the retching and purging, strengthen the weak intermittent pulse, and assist in warding off collapse. The careful observations of Gutmann have rendered improbable any specific action of the drug.

Some *prophylactic* power against cholera has been claimed for copper, as the neighbourhood of towns where large copper-works are situated, such as Swansea, Birmingham, and Rio Tinto, has been markedly free from the disease, but other circumstances, and other components of the vapour, such as sulphurous acid, must be taken into consideration (Med. Times, ii., 1854; ii., 1871). A similar immunity is recorded at the large powder factory at Madras, where the mixed chemicals are said to be exposed to a temperature of 500° F., which would be sufficient to develop sulphurous acid from the sulphur (Lancet, ii., 1873). More important is the fact, that amongst more than 5,000 copper-workers in Paris not one was attacked by cholera during an epidemic which affected other workmen in the proportion of about 1 in every 140; and of the former, not one died of cholera in the course of five epidemics (Burq, Lancet, ii., 1873). Dr. Clapton also remarked that the copper-workers seemed to have almost complete immunity from cholera and from choleraic diarrhoea, when it was very prevalent amongst the neighbours; and the same observation has been made by others. Still, such prophylactic virtue of copper is not usually recognised, perhaps because it is difficult to understand, but Dr. Clapton suggests as some explanation, the disinfectant power of the metal, and its destructive action upon fungi; the subject deserves further investigation, and has since been much discussed (B. M. J., ii., 1883; i., 1884; Revue, etc.). The evidence above given still remains, but Vulpian has negatived many of Burq's conclusions. Working in copper clearly does not antagonise the development of ordinary infectious disorders—such as typhoid or scarlatina, but it has, apparently, influence in lessening epidemics of, and mortality from, cholera.

Diphtheria.—In diphtheria the sulphate of copper has been found useful by some observers, as one of the most effectual

emetics, for the purpose of removing the false membrane; a solution of 5 gr. to the ounce may be given in divided doses—a teaspoonful only to young children, so as to induce moderate vomiting (W. Squire). In cases of formation of diphtheritic membrane on the cutaneous, or nasal, or vulvar surface, lotions of the sulphate have been found to destroy it, and to prevent its re-formation.

Phosphorus Poisoning.—Bamberger, Hulenburg, and others have recommended the sulphate in 3 gr. doses until emesis is produced; it is presumed to coat the poison and so lessen its absorption (*v.* Phosphorus).

Syphilis.—Aimé Martin and Oberlin have recently published the results of fifty cases of secondary and tertiary syphilitic affections treated with sulphate of copper; in many of these it is said to have acted more promptly than mercury; only in one patient vomiting took place on the first day, but very soon the metal was borne well; a green margin of the gums without an inflamed state of the mucous membrane was observed in a few cases, but disappeared soon; the remedy was given in solution, and 4 to 8 or 12 milligrammes were used daily. To a full *bath* 20 grammes were added (*Gaz. Méd. de Paris*, 1880). Zeissl has tried copper in syphilis, but his results were only partly satisfactory (*Wien. med. Presse*, 1880).

PREPARATIONS AND DOSE.—*Cupri sulphas*: as a tonic and astringent, $\frac{1}{4}$ gr. to 1 or 2 gr.; as emetic, 5 to 10 gr. (for adults)—best administered in divided doses at short intervals; a child may have $\frac{1}{8}$ to $\frac{1}{4}$ gr., according to age and strength, repeated every five to fifteen minutes till vomiting occurs, it should then be omitted for a time, or purging may follow. The following are not official. The *oxide* of copper has been used in doses of $\frac{1}{4}$ to 1 or 2 gr., and the *double chloride* with ammonium in $\frac{1}{4}$ or $\frac{1}{2}$ gr. doses, every two or three hours. A *linctura cupri acetici* has obtained some favour on the Continent with the support of Rademacher. It is prepared by mixing 24 parts of copper with 30 parts of acetate of lead in 136 parts of distilled water; boiling this in copper vessels, then adding 104 parts of spirit, and macerating for four weeks in a closed glass vessel, then filtering. It forms a green liquid of metallic taste, and is used as a remedy, “especially for hyperæmiæ, stases, and exudations”—5 to 15 drops and upwards are given thrice daily (Kissel, Husemann). As a *lotion*, 1 to 2 gr. of sulphate in the ounce, as a *parasiticide*, 10 to 20 gr. to the ounce may be used, or a stimulating astringent *ointment* or *oleate* may be made in the same proportion.

FERRUM—IRON, Fe = 56 (55·60).

Iron, the most abundant and the most useful of metals, occurs extensively in the mineral kingdom, its principal ores being either oxides, as the magnetic iron ore, or carbonates, as clay iron-stone. It occurs also in many mineral, so-called *chalybeate*, waters, generally as carbonate with excess of carbonic acid, but sometimes as ferrous chloride or sulphate. In the animal kingdom it is an essential constituent of blood, being contained, though only in minute quantity, in the hæmoglobin of the red corpuscles. It occurs largely also in the vegetable kingdom, and may be traced in the ashes of almost all plants. Sometimes the pure metal is found native, and is then commonly supposed to be of meteoric origin.

CHARACTERS AND TESTS.—Iron is hard, malleable, ductile and of great tenacity: its specific gravity is 7·8. Exposed to moist air it becomes covered with a reddish layer—rust—which is mainly hydrated sesquioxide. It forms two distinct classes of compounds, known as proto- or ferrous salts, and per- or ferric salts, and has a different atomicity accordingly. In ferrous oxide (FeO) and chloride (FeCl_2) it is diatomic, while in ferric oxide (Fe_2O_3) and chloride (Fe_2Cl_6) it is triatomic. The *ferrous* or *proto-salts* are commonly greenish in colour, less astringent and less soluble in alcohol; they have a marked tendency to absorb oxygen and to become ferric compounds, hence most of the official ferrous salts are in a partially oxidised state, but to some sugar is added to prevent such change, as in *syrupus ferri iodidi*, and *ferri carbonas saccharata*. *Ferric* or *per-salts* are generally brownish-yellow, astringent, soluble in alcohol and not prone to change; within the body, however, they are probably reduced to proto-salts.

The general tests for iron are: (1) Tannic and gallic acids give a bluish-black colour or precipitate with per-salts, and act similarly though more slowly with proto-salts. (2) The yellow prussiate of potassium (ferro-cyanide) gives a deep-blue precipitate (Prussian blue) with per-salts of iron, and a whitish or light-blue one with proto-salts. (3) The red prussiate (ferro-cyanide) gives no precipitate with the per-salts, but the liquid becomes of a dark colour: a deep-blue precipitate with proto-salts (Turnbull's blue).

Sulphuretted hydrogen and ammonium sulphide are also used as tests for iron salts; thus, in acid solutions of pure *ferrous* salts the former gives no precipitate, whilst with *ferric* salts it throws down a nearly white precipitate of sulphur, with reduction to the ferrous state: $\text{Fe}_2\text{Cl}_6 + \text{H}_2\text{S} = 2\text{FeCl}_2 + 2\text{HCl} + \text{S}$. Ammonium sulphide gives a black precipitate with both classes of salts. By acids iron is readily dissolved, with formation of metallic salts and evolution of hydrogen.

The form of the metal which is official is annealed iron wire, with a diameter of about 0.005 inch (about No. 35 wire gauge), or wrought iron nails free from oxide. The official *vinum* is prepared from 1 oz. of the former digested for thirty days with 1 pint of sherry.

COMPOUNDS OF IRON.

FERRUM REDACTUM—REDUCED IRON—QUEVENNE'S IRON.

This is metallic iron minutely divided by chemical processes, and must be distinguished from simple filings or powder produced by mechanical processes; it contains a variable amount of oxide of iron, and is a fine greyish-black powder, strongly magnetic, and showing metallic streaks on firm pressure; a little sulphide is sometimes present, and is liable to cause disagreeable eructation: dose, 1 to 5 gr. *Trochiscus Ferri Redacti*, 1 gr. in each.

LIQUOR FERRI PERCHLORIDI FORTIS—STRONG SOLUTION OF PERCHLORIDE OF IRON ($\text{Fe}_2\text{Cl}_6 = 325$).

CHARACTERS.—The liquid is at first black from the combination of some nitric oxide (NO) with the ferrous salt, but on heating the mixture the gas is expelled, and an orange-brown solution remains: it generally contains some free acid, and has a very strong styptic taste.

Liquor Ferri Perchloridi. Made by mixing 5 fl. oz. of the strong solution with a sufficiency of distilled water to make a pint (20 oz.).

Tinctura Ferri Perchloridi. Made by mixing 5 fl. oz. of the strong solution with 5 oz. of 90 per cent. alcohol, and sufficient distilled water to form 1 pint. These solutions become paler on exposure to light because of reduction of some of the iron to the ferrous state. The addition of glycerine disposes to the same change.

LIQUOR FERRI PERNITRATIS—SOLUTION OF PERNITRATE OF IRON ($\text{Fe}_2(\text{NO}_3)_6 = 484$).

It is a clear solution of reddish-brown colour, acid, and astringent.

LIQUOR FERRI PERSULPHATIS—SOLUTION OF FERRIC SULPHATE.

It is a dense solution of reddish-brown colour, is very astringent, and is used for making other preparations.

FERRI SULPHAS—FERROUS SULPHATE ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$).

The proto-sulphate of iron is the salt from which the greater number of the other compounds are prepared. Two forms of it are official—ferri sulphas (green vitriol) and ferri sulphas exsiccatus. The former occurs in oblique rhombic prisms, of greenish-blue colour and very styptic taste, which are soluble in water, but insoluble in spirit. Exposed to air they absorb oxygen and turn brown from the formation of ferric sulphate: if nearly free from any ferric salt, the precipitate with yellow prussiate of potash will be nearly white. The crystals effloresce slightly in dry air; at 238°F . they lose most of their water of crystallisation, and at 400° only one atom of water is retained, and the salt becomes a yellowish-grey powder.

Ferri Sulphas Exsiccatus—Dried Sulphate of Iron ($\text{FeSO}_4 \cdot \text{H}_2\text{O}$). This does not alter on exposure, and is not gritty: 3 gr. are equal to 5 gr. of the crystallised salt.

FERRI IODIDUM—IODIDE OF IRON ($\text{FeI}_2 = 310$).

(*Not-official.*)

CHARACTERS.—A crystalline, green substance with a tinge of brown, containing about 18 per cent. of water of crystallisation and a little oxide of iron, without odour, deliquescent, soluble in equal parts of water, forming a greenish solution which very readily absorbs oxygen, and changes into free iodine and ferric peroxide. It is decomposed also by heat, emitting iodine vapours; the altered solution may, however, be restored by warming with more iodine and iron, and may be preserved in strength by keeping a piece of iron in it; so that as iodine is liberated it can recombine to form iodide. Syrup will preserve it to a great extent, and it is in the form of syrup that it is most frequently ordered; it is incompatible with alkalies and their carbonates.

Pilula Ferri Iodidi: contains 1 gr. in $3\frac{1}{2}$ (not official).

Syrupus Ferri Iodidi: 11 min. of this syrup contain 1 gr. of ferrous iodide.

FERRI CARBONAS SACCHARATUS—SACCHARATED IRON CARBONATE.

This is a mixture of carbonate of iron ($x\text{FeCO}_3 \cdot y\text{Fe}(\text{OH})_2$) with peroxide of iron and sugar; the carbonate (if reckoned as anhydrous) forming about one-third.

There is no ferric carbonate, but what is often sold as carbonate is a brown ferric oxyhydrate containing only a trace of the desired salt, which is

very unstable and prone to oxidation; to preserve it from this as far as possible, it is rubbed up with sugar.

Pilula Ferri—Iron Pill—Blaud's Pill.

This pill contains sulphate of iron (15 parts) and carbonate of sodium (9·5 parts). In mixing, the ferrous sulphate and sodium carbonate undergo double decomposition, so that each pill contains about 1 gr. of carbonate of iron.

FERRI PHOSPHAS—PHOSPHATE OF IRON.

This contains at least 47 per cent. of ferrous phosphate ($\text{Fe}_3(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}$), with ferric phosphate and some oxide.

CHARACTERS.—A slate-blue amorphous powder, almost tasteless, insoluble in water, soluble in acids.

Syrupus Ferri Phosphatis.

Syrupus Ferri Phosphatis cum Quinina et Strychnina.

FERRI ARSENAS—ARSENATE OF IRON.

Contains the ferrous salt ($\text{Fe}_3(\text{AsO}_4)_2 \cdot 6\text{H}_2\text{O}$) and some ferric arsenate and oxide.

CHARACTERS.—Arsenate of iron is an amorphous powder, white when first formed, but becoming grey or greenish-blue from absorption of oxygen: insoluble in water; soluble in hydrochloric acid. Thrown on live coals it evolves the garlic odour of arsenic, and is essentially an arsenical remedy, for the quantity of iron in any admissible dose is insignificant.

LIQUOR FERRI DIALYSATUS—SOLUTION OF DIALYSED IRON
(*Not Official*).

CHARACTERS AND TESTS.—It is a clear, dark, reddish-brown solution of oxychloride, freed from acid by dialysis, and without markedly ferruginous taste. It is neutral to test paper, and has a sp. gr. of 1·047.

FERRUM TARTARATUM—TARTARATED IRON.

CHARACTERS.—It occurs in dark garnet-coloured scales; soluble in water, sparingly so in spirit.

FERRI ET AMMONII CITRAS—CITRATE OF IRON AND
AMMONIUM.

CHARACTERS.—It occurs in transparent ruby-red scales, of sweet astringent taste and slightly acid reaction, soluble in water, almost insoluble in spirit. If boiled with soda or potash, it evolves ammonia, but alkaline

carbonates do not readily decompose it, and it may, therefore, be given with them in effervescence with citric acid: the iron salt should be put into the acid solution.

FERRI ET QUININÆ CITRAS—CITRATE OF IRON AND QUININE.

CHARACTERS AND TESTS.—Occurs in greenish-yellow scales which become darker by age; they are at first deliquescent and very soluble in cold water, but become less so on exposure to light; it has a chalybeate, and at the same time a bitter taste. It should contain 20 per cent. of Fe_2O_3 , and 16 per cent. of quinine, but the proportion of the latter varies, falling sometimes to 4 per cent. The solution is slightly acid: soda precipitates the reddish-brown peroxide, $\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$, and ammonia a white deposit of quinine.

The citrate of quinine with *iron* and *zinc*, with *iron* and *strychnine*, and many other double compounds, have also been prepared in granular effervescent form. There are also a number of preparations of iron which are not official; the most important of these are the *bromide*, the *hypophosphite*, the *valerianate*, the *oxalate*, the *lactate*, the *succinate*, and the *sulphate of iron* and *ammonium*.

ABSORPTION AND ELIMINATION.—The absorption of drugs is now commonly accepted as a necessary condition of their general action on the system, and yet the absorption of medicinal doses of iron has been doubted by some eminent men, mainly because, after giving the drug to animals, they have failed to detect an increased quantity of it in the vena portæ or in the urine (*v. p.* 615). On appeal to the clinical evidence of improved colour and tone after the use of iron in anæmia, the objectors attribute such results to a local tonic action upon the gastric mucous membrane, leading to improved digestion; but apart from iron salts having often a contrary effect on the stomach, mere improvement of digestion would scarcely account for the rapid chemical changes produced in the blood, and the corresponding benefit to the general condition. It seems more reasonable to allow that the medicine, which is proved to be soluble to some extent at least in the digestive juices, is really absorbed to the extent of its solubility. Most articles of diet contain iron,¹ and it is freely admitted that iron in such organic combination can be readily

¹The amount present in ordinary diet is estimated by Stockman (*Journ. of Physiol.*, Nov., 1895) at 8 to 11 mg. a day (about $\frac{1}{8}$ gr.), and the total amount excreted daily at less than 6 mg.

absorbed and utilised for the needs of the organism; if there be some failure in its supply or assimilation, then colour and strength fail, and conversely health and colour usually return when the ordinary medicinal inorganic preparations of iron are added to the nutriment,—the inference being that they have become absorbed.

Definite facts in proof of absorption are such as the following: Tiedemann and Gmelin administered to a horse about 6 dr. of sulphate of iron, and found an increased amount of the metal in blood from the splenic and hepatic veins, and sometimes in the lymph also. Menghini recorded a distinct increase in the amount of iron in the blood of dogs when he added the metal to their food (Bayle, *Bib. de Thérap.*, v., iv.).

Quevenne, in his careful memoir, says that only a minute quantity can be detected in normal urine, but after medicinal doses the amount is increased slightly, and in the bile and fæces the increase is greater (*Archives de Physiol.*, 1854), (*cf.* p. 615). Bistrow verified the presence of nearly double the ordinary amount of iron in the milk of a goat after the administration of 15 to 40 gr. of lactate of iron, the increase of elimination beginning forty-eight hours after the dose (*Virchow's Archiv*, Bd. xlv., 1869). Objections have recently been taken to these and many similar observations, chiefly on the grounds of inaccuracy, the sources of fallacy arising from the constant physiological presence of iron in the tissues in varying amounts.

More modern observations are those of Rabuteau, who passed into the stomach of dogs doses of 4' to 8 gr. of protochloride of iron, and on killing the animals two or three hours after, found only small amounts of iron in the gastro-intestinal canal, most of it having been absorbed (*Comptes Rendus*, lxxiii.). This is confirmed by Cervello, who gave a dog 0.015 gramme of ferric chloride by the mouth and two and a half hours after recovered only 0.006 gramme of ferrous chloride from the intestinal canal (*Archiv. gen. per le Sci. Med.*, 1880). Kunkel fed two dogs on the same diet, but to one gave iron in addition; after some time he killed them, and on determining the amount of iron in the various organs, found that those of the dog which had taken iron along with its food contained considerably more of the metal than those of the other dog (*Pflüger's Archiv*, 1891).

Further, some experiments by Coppola seem to me conclusive. He fed cocks on a diet containing no iron, and found that the amount of hæmoglobin in the blood diminished rapidly and considerably; on adding lactate of iron to their food this loss was soon made good—the iron salt must have made up the deficiency, and therefore must have been absorbed (Lo Sperimentale, 1890).

It is true that such absorption occurring through the gastrointestinal mucous membrane may be often partial and incomplete with any one dose, yet the occurrence of some seems to be proved by our clinical experience in anæmia, supported by the experimental results quoted. It doubtless varies according to the preparation used, the condition of the digestive juices, and the state of the stomach as to food, etc. Accidental circumstances may also influence it, as Woronichin states that the simultaneous administration of the chloride of sodium or potassium increased absorption and elimination of iron (Ztschr. der Aerzte zu Wien, 1868), and Nasse that fats have a similar effect (Cbl. f. med. Wiss., 1877). Brücke states also that after prolonged administration of iron to rabbits the system became so charged with the metal that it was no longer retained, but passed almost wholly in the urine (Husemann), thus implying that continuous absorption to form an integral constituent of the organism does not occur under the circumstances.

As to the *mode* in which absorption is effected,—it is possible that the soluble salts are absorbed unchanged, or in loose combination with albumin. Rabuteau held that the sesqui-oxide and other compounds were converted first into perchloride and then into protochloride, in which form they were finally taken into the blood, and the generally held opinion at present is that the carbonate, the various oxides, and reduced iron are converted into protochloride by the hydrochloric acid of the gastric juice before being absorbed. Bunge, whilst allowing this, states that in the duodenum the carbonate of sodium always present there converts the perchloride into ferric oxyhydrate which is kept dissolved by organic matters, while the protochloride becomes protocarbonate which is also soluble in the intestinal contents.

It was formerly held that all proto-salts became quickly changed into per-salts in the body, because this change occurs so readily outside, but various conditions will prevent or even

reverse this. Thus, Quevenne notes that a natural protocarbonate remains as such in many mineral waters, that per-salts are reduced by alkaline tartrates, by charcoal, or simply by cold. Stenhouse found per-salts to be reduced by organic substances generally, and C. Bernard, after injecting a per-salt into the jugular vein, recovered only a proto-salt from the urine. Bubnow also has shown that if ferric salts be given by the mouth they gradually become reduced to ferrous during their passage along the intestinal canal (*Ztschr. f. phys. Chemie*, 1883), and Glaevecke after subcutaneous injection of a ferric salt found it ferrous in the urine, but ferric in the blood and peritoneal fluid (*Archiv. f. expt. Path.*, 1883). Zaleski, however, has found both ferrous and ferric organic compounds in the liver, and it is possible that the state of oxidation may be dependent on local or temporary conditions. When iodide of iron is given, the whole of the *iodine* has been found eliminated in the urine after a few days, while but little of the *iron* has passed out (Quevenne, Melsens), proving that complete separation occurs in the system. It has been suggested also that salts of the organic acids—lactates, citrates tartrates—have their acids rapidly oxidised, leaving the iron in the organism. Strong solutions of the per-salts must, for their first effect, coagulate some of the albuminous matters met with in the stomach, and Mitscherlich, H. Rose and others have shown that such combinations are readily soluble under these conditions.

It is now generally agreed that absorption takes place in the duodenum and jejunum by the epithelial cells of the villi, which pass on the iron to the leucocytes and so to the general circulation—for the metal has been found in the cells and the leucocytes by staining agents (Hall, Leipzig, 1894-6, and Macallum, *Journ. Physiol.*, 1894). It lies in very minute particles which can be rendered visible by ammonium sulphide and hæmatoxylin (quoted by Stockman). It seems probable from Zaleski's (*Ztschr. f. phys. Chem.*, 1886) and other researches, that iron is deposited in the spleen and liver, where it is retained and elaborated gradually into more or less complex organic compounds (one is ferratin); this view is strengthened by the fact that it is not eliminated by the kidneys (*vide infra*) and therefore probably does not immediately reach the general circulation. The organic compounds thus formed are ultimately carried by the blood stream to the blood-

forming glands to make hæmoglobin, or, if not needed for this purpose, are gradually excreted by the ordinary channels.

In studying the *elimination* of iron it is necessary to determine what takes place under physiological conditions when no medicinal preparations of the metal are being administered. As already stated, an ordinary diet supplies about one-sixth of a grain of iron per diem in organic combination, and this suffices to make good bodily wear and tear in health. Minute traces of the metal are present in all excretions, but the great mass is found in the fæces, although it was formerly thought and is still frequently stated that the bile, and to a lesser extent the urine, were the chief channels of excretion of effete or useless iron. From Dr. Young's analyses (Journ. Anat. and Phys., 1871) it is estimated that about $\frac{2}{3}$ gr. of iron is excreted daily in the bile, and Kunkel, Hoppe-Seyler and others regard it as varying from about $\frac{1}{3}$ to $\frac{1}{2}$ gr. Novi, in dogs with biliary fistula, got somewhat similar amounts, but they seem unduly large—Stockman found but nearly $\frac{1}{10}$ gr., and Bunge only unweighable traces of iron in large quantities of bile from man, oxen, pigs and dogs (Physiol. Chemistry); Hamburger in a dog fed on flesh also failed to get more than traces. Anselm found $\frac{1}{9}$ gr. in the bile of a dog during twenty-four hours (Arbeiten des pharmak. Instit. Dorpat., 1892). These latter researches are more likely to be accurate, as they were made with a full appreciation of the difficulties involved, and lead to the conclusion that the amount of iron in the bile is extremely small. Nor is any considerable quantity excreted normally in the urine. As early as 1824 Wöhler failed to find iron in this secretion, Quevenne and Boussingault, Fleitmann, Gottlieb and others estimate it only at from $\frac{1}{22}$ to $\frac{1}{11}$ gr. per diem, and all recent observers are agreed that only minute traces are ever present in health. Hamburger states the amount at $\frac{1}{8}$ gr. daily, but Damaschin (Arbeiten des pharmak. Instit. Dorpat., 1891) and Kumberg (*ibid.*) have definitely shown that only about 1 milligramme ($\frac{1}{85}$ gr.) is excreted in the urine of a healthy adult in twenty-four hours, while Socin found only unweighable traces, and sometimes none (Ztschr. f. phys. Chemie, 1891). When iron salts are given *by the mouth*, Gottlieb and Anselm (*loc. cit.*) have conclusively proved as against Quevenne that the normal amount of iron in the bile is not augmented, and there is a consensus of opinion (Hamburger,

Bunge, Damaskin, Kumberg, Socin, Jacobi and others) that the amount in the urine is also not increased (*cf.* p. 612).

When iron is given subcutaneously or by a vein, about 50 per cent. of it is retained by the liver, about 10 per cent. or less is excreted in the urine, while the remainder is deposited in the spleen, kidneys, intestinal wall and bone-marrow. Two or three hours after administration the blood is quite free from iron (Jacobi, *Archiv f. expt. Path.*, 1891). According to Gottlieb and others the greater part of the iron is ultimately excreted by the mucous membrane of the intestinal canal; further, in starving animals or those fed on an iron-free diet, there is always a considerable amount of iron excreted into the intestine derived from the breaking down of iron-containing tissues (Coppola, *loc. cit.*; Forster, *Ztschr. f. Biol.*, 1873, and others). Excretion is always very gradual and only a small amount of iron can be detected in the gastro-intestinal wall at any one time.¹

Hoffmann (*Munch. Med. Woch.*, 1899; Wright's *Med. Annual*, 1901) made a series of observations on rabbits, some of which were given iron and others not. Some were in normal health, while others were rendered artificially anæmic by blood-letting. Particular attention was paid to the bone-marrow, spleen, and lymphatic glands, as specially concerned in blood formation, but the liver, kidneys, and small and large intestines were also examined; the blood corpuscles were counted and the hæmoglobin estimated. Various preparations of iron and hæmoglobin were tested as regards qualitative and quantitative absorption. He found that all forms of iron were absorbed in the duodenum, and entered the circulation combined with albuminous matter. It could be demonstrated in large quantities in the spleen, liver, and especially in the bone-marrow where crowds of iron-laden cells were present, in the tardy blood-stream, in the parenchyma itself, and in the network of vessels within it. The marrow alone exhibited after blood-letting a corresponding regenerative activity, an active hyperplasia of its parenchyma. The restoration of the red corpuscles was more rapid, the bone-marrow richer in its contents after the administration of iron, while the spleen and lymphatic glands

¹ More as to the literature on absorption and elimination of iron is to be found in a paper by Dr. R. Stockman, "The Treatment of Chlorosis by Iron and some other drugs" (*B. M. J.*, i., 1893).

showed no difference. Iron given without blood-letting caused some increase of the red cells circulating and of the fat, but not of cell-formation in the bone-marrow. The restoration of the hæmoglobin was not so complete; there was no apparent increase in the colouring matter. Special preparations of iron are unnecessary, and those of hæmoglobin irrational, according to this author.

The action of iron on the bone-marrow throws light on the nature of chlorosis. It is probable that this affection consists in a diminished capability of production, leading to hypoplasia of the bone-marrow, in severe cases associated with a hypoplasia of the blood-conveying structures. This weakness of the blood-forming apparatus betrays itself in the depreciated production of erythrocytes, which are morbidly altered in form and in amount of contained hæmoglobin. Hoffmann thinks that this is the only theory as to the nature of chlorosis consistent with the specific action of iron, and that it is supported by the beneficial effect of venesection in this affection, in consequence of its being a stimulant to the blood-forming bone-marrow.

As already mentioned it has been supposed by Buchheim, Dujardin-Beaumetz, Kobert, Kletzensky and others that iron preparations are not absorbed, but exert their beneficial effect in anæmia by a stimulating action on the gastro-intestinal mucous membrane, whereby appetite and digestion are improved, so that the food supplies the necessary iron to reconstitute the blood. They base their arguments chiefly on the fact that iron given by the mouth does not increase the amount excreted in the bile or urine, hence that it cannot be absorbed; and further that the iron of the food is sufficient to supply any deficiency present. It has been shown, however, that the absence of iron from the urine and bile is fully accounted for by its retention in the liver and subsequent excretion through the intestinal mucous membrane, and further, mere stimulation of the gastro-intestinal tract by other drugs has been abundantly proved inadequate to cure anæmia.

Bunge reintroduced a theory of the action of iron which attracted much attention (*v. Manganese*). He holds that the ordinary preparations of iron cannot be absorbed from the alimentary canal, and that only iron organically combined—as found in food-stuffs—can be utilised to form hæmoglobin. In chlorosis, he says, digestion is greatly disturbed, with formation

of sulphuretted hydrogen in the alimentary canal. This gas combines with and separates out the organic iron in the food, forming sulphide of iron, an *inorganic* compound which according to him cannot be absorbed; hence the blood loses its necessary supply of iron, and anæmia results. When in this condition inorganic iron is given medicinally, he supposes it to combine with and neutralise the sulphuretted hydrogen, and thus to protect the organic iron of the food, which becomes absorbed and goes to form hæmoglobin. It is, however, simply an assumption, that sulphuretted hydrogen is found in the bowel in great excess in chlorosis, and Stockman has shown that ferrous sulphide given by the mouth is as curative as other iron preparations, although it is scarcely likely that it can absorb any sulphuretted hydrogen in the intestinal canal. Moreover small doses of iron ($\frac{1}{4}$ to $\frac{1}{2}$ gr. daily), given *subcutaneously*, will cure anæmia satisfactorily, and iron given in these small amounts can scarcely tone up the gastro-intestinal mucous membrane, or neutralise any (hypothetical) excess of sulphuretted hydrogen in the bowel.

PHYSIOLOGICAL ACTION.—*External.*—Compounds of iron with the mineral acids acts as caustics, irritants, or simple astringents, according to the kind and strength of preparation used; they are also antiseptic. A caustic, destructive action is exerted by the solid perchloride, especially upon raw surfaces or mucous membranes, but it is not so deep or thorough as that of the mineral acids alone, because of the rapid coagulation of albumin. The astringent effect of dilute preparations is explained partly by such coagulation, and partly by the constriction of capillaries.

Kulischer has made curious experiments to test the comparative effects of certain astringents and hæmostatics; having divided some blood-vessels in the limbs of frogs, he stayed the bleeding with different astringents applied for various lengths of time, and then injected liquid into the larger blood-vessels, and calculated the amount of force required to re-open those that had been divided and closed; from his results he concluded that of iron solutions a strength of 30 per cent. gave the best results, and the good effect was proportioned rather to such strength than to the duration of its application (Schmidt's Jahrb., 1876). Some researches by Rosenstirn upon the same subject, though conducted in a different manner, show also how much the action is depend-

ent upon a definite strength of solution, and enable us to compare the effect of iron with that of other astringents. He examined and measured under the microscope the amount of contraction of the blood-vessels in a frog's mesentery after the application of 10 per cent. solutions of nitrate of silver, acetate of lead, and perchloride of iron, and the last did not act at all; he then used 50 per cent. solutions, and found the iron solution very effective—it narrowed both veins and arteries at the place of application, arrested circulation, and acted as a true styptic on the blood itself; the adjacent vessels became dilated.

The coagulum formed in the living vessel by perchloride of iron is soluble, to some extent, in the stream of alkaline blood, and especially so if the astringent solution used be unduly weak; it is also soluble in slightly acid liquids, but is rendered more consistent by combining the iron with alkaline chlorides (Piazza, *Bull. de Thérap.*, 1868). With lactate of iron the blood-clot is said to form more slowly, and to be more permanent.

The antiseptic powers of astringent iron preparations are connected with the coagulation of albumin, and strong solutions are fatal to the lower forms of vegetable life. Ferreil ascertained that the neutral strong solution of perchloride arrested decomposition that had commenced in a blood-clot, and formed with fresh blood a coagulum that remained unaltered for many months (*Union Méd.*, 1859). Iron salts are now extensively used as disinfectants: of ferrous sulphate, 10 lb. are required for the hundred cubic feet of sewage.

PHYSIOLOGICAL ACTION.—*Internal.*—**Circulatory System.**—Under the use of iron preparations the pulse is said to become more full and forcible, and the colour of the face and mucous membranes more florid, but it is questionable if this occurs when the health and blood-condition are normal. It is also commonly said that if iron be pressed beyond a certain point, symptoms of plethora and of congestion set in, as shown by flushes and giddiness, engorged viscera, and tendency to hæmorrhage, although such effects must be rare, if they ever do occur. The blood will not take up more than a certain quantity, and it is impossible by giving iron to raise the corpuscles or hæmoglobin much above the normal amount. Hirtz asserts that he has never seen congestive symptoms, vertigo, etc., except from the

excessive use of chalybeate waters containing carbonic acid, to which gas he attributed such effects (Nouveau Dict.); and Nothnagel and Rossbach (Arzneimittellehre) state that in the *healthy* they have never been able to observe any physiological effects whatever after giving medicinal doses of iron by the mouth. In anæmics, on the other hand, all the bodily functions gain tone and vigour; *i.e.*, if the remedy agree and be given in suitable form and dose.

According to Sasse and Pokrowsky, the use of iron salts increases the heart's action, but their observations were limited to sick persons, and there is no doubt that in disease the circulatory and other systems may be greatly stimulated, not so much by the direct action of iron as secondarily by its reconstituent action on the blood. We have seen that iron is probably never absorbed in large amounts at one time, and that what is absorbed is retained in the liver until it has been elaborated into an organic compound suitable for the needs of the organism; we should therefore expect its action to be slow and "alterative" in character rather than rapid and striking, and experience shows this to be the case, as an immediate and direct effect on the heart or circulation is seldom observable. On injecting a neutral tartrate of iron and sodium into the jugular vein, Meyer and Williams found that the blood pressure fell greatly from paralysis of the vascular walls, the heart muscle itself not being so much affected (Archiv f. exp. Path., xiii., 1881), but the effects of iron thus administered are scarcely comparable with those seen after giving it in the usual way.

According to the most trustworthy analyses, 1,000 parts of blood contain about 0.547 of iron. Hæmoglobin contains 0.42 per cent. as a constant quantity in organic combination in the red corpuscles; when dried these contain seven times as much as the fibrin, and four times as much as the serum (Bous-singault). Being required then for the normal constitution of red blood, iron is essentially a *food*, but since illness follows deficiency in the number or quality of corpuscles, and iron in substance will often remedy such illness, it equally comes within our province as a *medicine*, and from its curative effects we may, inverting the general rule, deduce some part of its physiological action. That it can increase the number of red corpuscles

in anæmia is shown by the observations, *e.g.*, of Rabuteau, who counted them by Malassez' method, in a case of chlorosis before and after twenty days' treatment by protochloride of iron, and found the number in a cubic millimetre to be nearly doubled (Gaz. des Hôp., Jan., 1875), and in a specimen of blood analysed by Prof. Simon the globulin and hæmatin were more than trebled (Animal Chemistry, Syd. Soc.). I need not multiply examples of this fact (though it has been denied), but there is something further to be learnt from the numerous and careful observations of Hayem on the blood of anæmic persons. He found that in cases of moderate chlorosis the *number* of corpuscles was not markedly less than normal, but they were altered in shape and size, apparently in consistence, but most markedly in *colour*, so that a given quantity showed a red tint not deeper than that of half the number of normal corpuscles. Further, after a course of iron the number of corpuscles in the same patient was not always increased, sometimes it was diminished, but then the corpuscles individually had grown larger and of normal shape, and of so good a colour as to equal even a greater number of the ordinary kind; he concludes then that iron acts by improving the internal nutrition of the discs, "it solicits them" to take up more colouring matter. These observations confirm the older ones of Le Canu (Thèse, 1847), that iron is the main constituent of hæmatin, is inseparable from the colouring matter, and must be at least an important element in the colour itself. Hayem's conclusions are of still more importance as bearing on the assertions of Denis and of C. Bernard, that there is no real deficiency of iron in chlorotic blood, because they prove such a definite change in its *vital* characters under the medicinal use of the drug. Granted that there is no numerical, there is clearly a physical or a vital change produced by iron; and although it may be true that ordinary nutriment contains as much iron as should be wanted (Bernard), yet it seems equally true that we may sometimes have to give much that we may get a little absorbed (Gubler), that we must therefore give it *en masse*, as we do, and (apart from all theory) Hayem furnishes us with a rational basis for our therapeutics.¹ That

¹ Careful observations on the good effect of both iron and arsenic on the size, shape and number of the corpuscles have been made by Dr. Willcocks (Pract., ii., 1883).

the proportion of iron can vary in blood is proved by the analyses of Picard (*Comptes Rendus*, Nov., 1874); in 100 cub. centim. taken from three dogs, respectively young, adult, and weakened by hæmorrhage, he found that the amount of iron was .092, .065, and .041, and he established also the fact of a definite and constant relation between the amount of iron in any specimen of blood, and the amount of contained oxygen as liberated in vacuo from quantities of 100 cub. centim. As the administration of iron increases the amount of hæmoglobin in the red corpuscles, it must thereby increase the oxidation processes in the body, seeing that hæmoglobin is the oxygen carrier of the organism. The researches of Picard, Preyer and Hüfner proving a definite ratio between the amount of iron and of oxygen contained in the blood are of much interest in this connection, and it is an axiom that iron preparations exert their best curative effect when the supply of oxygen is ample.

Different action of proto- and per-salts.—Blake has published some experiments to show that there is a marked difference between the action of proto- and per-salts on the blood and circulation (*Journ. Anat. and Phys.*, 1869), but the method of experimenting was fallacious. He injected solutions of ferrous and ferric salts directly into the blood-stream, and the differences in effect were undoubtedly due to the different action of the two classes of salts in determining coagulation of the blood. Meyer and Williams, Kobert and others, using a neutral double salt of iron which does not coagulate albumin, have shown that iron *per se* always has the same action, though *ferric* salts are more astringent and coagulate albumin much more markedly than ferrous; this has an important bearing upon their use for local injections as styptics, etc. The compound which *ferrous* salts form with albumin is soluble, and is not a coagulum, hence they are not nearly so useful for local astringent purposes. Gaglio states that *ferrous* lactate, tartrate and sulphate, when injected into the blood, actually *hinder* its coagulation (*Rev. des Sc. Méd.*, 1891).

Muscular System.—Iron in large doses is said to act like those substances which, although not affecting the excitability of the muscle fibre, reduce its working power (Kobert, Brunton); on the other hand small doses of iron are said to increase the amount

of work that muscle is capable of doing. Brunton and Cash have shown that it causes a slow contraction of the blood-vessels.

Neuro-Muscular System.—The effect of iron when given hypodermically in frogs varies with the dose; at first there is some degree of excitement, but ultimately paralysis ensues. With large doses the excitability of striped muscles is lowered, but not that of the cardiac muscle. The vaso-motor nerves, particularly the splanchnics are paralysed (Brunton). The tonic effect of iron on the nervous system is probably indirect through the blood.

Digestive System.—Most of the soluble salts of iron have an inky astringent taste, and by continued use stain the teeth and mouth of a dark colour (sulphide of iron). Compounds with a mineral acid exert a local astringent action on the mouth and stomach, and if the dose be small and diluted, may improve the tone and functional power of the gastric mucous membrane: but these or any other preparations, if given in undue quantity, may irritate and cause indigestion (from lessened secretion), with sense of weight, nausea, or diarrhoea. Iron pills taken in quantity have caused obstruction, and sometimes accumulation has occurred from a soluble salt, as in a case where 20 gr. of the citrate were taken thrice daily for some weeks—an insoluble black sulphide was apparently formed (B. M. J., ii., 1887).

Quevenne experimented with gastric fluid withdrawn through a fistula from the stomach of dogs, and judged of the effects of iron on digestion by the precipitates of peptones obtained from the fluid at certain periods after a meal. There was less precipitate when the juice was acid than when partly neutralised, but he concluded that various forms of iron, given with food, improved the character and amount of the precipitate: they did not increase the proportion of pepsin, nor alter the duration of the digestive process, but were quite readily absorbed, and the dogs thrived and gained flesh under their use. On the other hand, when given without food and especially in the metallic form, iron did not stimulate the formation of sufficient secretion to dissolve itself, but acted as a foreign body and impaired digestion: 10 to 20 gr. of reduced iron would cause diarrhoea, hence a reason for the ordinary rule of ordering iron preparations at the time of a meal, and in small doses (3 to 5 gr.): these observations have been confirmed by more recent observers. Petit was

satisfied that small doses did not hinder peptic digestion, though large ones might do so by taking up hydrochloric acid (*Journ. Thérap.*, 1880). Düsterhoff reported ferric salts rather more hurtful than ferrous, but insoluble preparations such as reduced iron did not retard the digestive process (*Dissert.*, Berlin, 1882). Bubnow agreed and found that even large doses only retarded without disturbing: pancreatic digestion also was but slightly affected (*Strassburg Zeitschr.*, 1882). The sulphate and chloride of iron have sometimes been taken, by mistake or for criminal purposes, in large quantities (1 oz. and upwards), and have caused violent pain and vomiting, with other symptoms of irritant poisoning and gastro-enteritis, but the cases have rarely proved fatal (Taylor).

Secretion. Astringent preparations will usually lessen the secretions, especially those of the gastro-intestinal tract. Upon the kidney in health, the effect as to quantity of secretion is not much, but irritation of the bladder and urinary tract may lead to increased frequency of micturition. In some persons, however, and in some diseases, iron preparations, especially the tincture of the perchloride, the citrate and the tartrate, have proved good diuretics, directly or indirectly: the tincture, in fact, was termed by Simpson a "renal purgative" when recommending it in "surgical fever" (*Med. Times*, i., 1859). Rabuteau comparing the results of five days when taking daily 2 gr. perchloride of iron, with a like period on the same diet but without iron, found that the quantity of urine was not increased, nor the urea, but the solid constituents were somewhat augmented owing chiefly to an increase in the phosphates.

From what has been previously said regarding the absorption and excretion of iron and from clinical experience, I incline to the conclusion, that iron as ordinarily given has no diuretic power. The case is different when iron is injected directly into the blood, as it then comes to be excreted partly by the kidneys, and thus Kobert, after injecting iron into the veins of animals, found the drug in the epithelium of the convoluted tubes and in the tubes themselves,—thus accounting for renal irritation; he did not find it in the glomeruli (*Revue*, t. xxii., 1883).

The secretion of milk has diminished or ceased in cows drinking a ferruginous water, and in some suckling women taking

a course of iron (Martin); Bistrow records a similar result in a goat under the use of lactate of iron (*v. p.* 615): on the other hand, there is clinical evidence that non-astringent preparations taken by *anæmic* women during lactation will improve the secretion as well as the general health (Routh, *Med. Times*, i., 1859). The effect is clearly that of a restorative, and as we find so often in the use of iron, it will vary with the preparation and the patient taking it.

Generative System.—From an early period iron has had the repute of specially stimulating this system. A classical cure by iron-rust of impotence amongst the Argonauts is commonly quoted, and we may rescue from oblivion the curious marriage-contract said to be common at one time amongst the burghers of Frankfort, to the effect that their wives should not visit the iron springs of Schwalbach more than twice in their lives, for fear of being too fruitful (Dr. Jacques, *Thèse*, Paris, 1843). There is clinical evidence of its value in sexual debility, and in derangement or suppression of the ovarian function, but it seems more explicable by a general tonic and hæmatinic power than by a special local action, though Trousseau attributes to iron aphrodisiac power. The tincture of the perchloride is in somewhat common use as a supposed abortifacient. Taylor regards it as a dangerous drug for pregnant women, but his examples scarcely corroborate this, and the clinical evidence and experience as to medicinal doses mentioned later on tend to an opposite conclusion. We may recognise, however, that very large doses of astringent preparations are not safe—they may injure by general irritation or local congestion, as shown in some cases reported in *Med. Times*, ii., 1860.

SYNERGISTS.—Manganese, arsenic and most tonics and acids: as astringent,—ergot, turpentine, etc.

ANTAGONISTS.—INCOMPATIBLES.—Weakening and fluidifying agents such as alkalies and mercurials: the former are also, together with sulphur and tannin, chemically incompatible with acid iron preparations. One cannot prescribe the greater number of vegetable bitters with iron, as they contain tannin; quassia and calumba form exceptions to this rule. *Digitalis* preparations become somewhat inky with iron because of the contained tannin and are better given separately, but dilute

phosphoric acid will clarify the mixture if prescribed. Gubler mentions nicotine as antagonistic: although arsenic has been mentioned as synergic, this must be understood of only small doses: full doses of the hydrated peroxide of iron are antidotal to arsenic (*v. p.* 501).

THERAPEUTICAL ACTION.—*External and Internal.*—Iron in the metallic form was in early use as an astringent and roborant, though we note the absence of any mention of it by Hippocrates. In extraordinary demand at the early part of the last century as a secret remedy, under the names of “Elixir d’Or,” “Gouttes d’Or,” “Teinture de Bestuchef,” etc., the perchloride solution with ether was priced at a golden louis per $\frac{1}{2}$ oz., procured pensions and promotions for its makers, and served as a present for sovereigns; but when its last patentee revealed the secret, “for fear his death should lose it to the world,” and when Catherine of Russia purchased the precious recipe for many thousand roubles, and presenting it to the St. Petersburg College of Medicine allowed it to be published (1780), this remedy which had been held to cure “gout and epilepsy, cramps and paralysis, rheumatism and hypochondriasis,” sank into an obscurity as little deserved as was its previous reputation. Bayle, whose treatise is an excellent epitome of the therapeutical knowledge of his time, mentions only the metal and the carbonate as remedies in neuralgia and chlorosis (*Bib. de Thérap.*, iv., 1837), and the general use of soluble ferric compounds dates really from about 1850.

Hæmorrhage.—The astringent compounds of iron with a mineral acid are excellent local styptics in all forms of capillary hæmorrhage, such as from leech-bites, wounded gums, hæmorrhoids, bleeding from the nose, etc. The part should be thoroughly cleansed from clot, and then a plug or compress moistened with the solution should be firmly pressed upon it, or in cavities an injection (diluted) may suffice. Sir James Simpson strongly commended a solution of the perchloride in glycerin, used it freely for all forms of hæmorrhage, and with special success in some severe cases of bleeding from the vagina and uterus (*Med. Times*, i., 1858). Demarquay, Lallemand and Deleau were using the same hæmostatic with great advantage in France about the same time (*Gaz. des Hôp.*, 1858-59).

The liquor ferri perchloridi fortis, B.P., is serviceable for the purpose, but is more acid, and proves often more irritating than need be, and may be well diluted with an equal part of water or glycerin. The liquor ferri sulphatis is preferred by many surgeons, and by others the liquor ferri subsulphatis, or Monsel's solution¹ of the American Pharmacopœia; this is made with sulphate of iron, sulphuric and nitric acids, and is much less caustic and irritant than our solution; it is used in rectal hæmorrhage—1 part to 4 of water (Allingham, *Lancet*, i., 1874)—and the “hæmostatic cotton” used by Marion Sims was prepared with it. The so-called “iron alum” is probably an equally effective preparation; it is well spoken of as a local application to the uterus for hæmorrhage (*L. M. Record*, 1884).

Tonsillar Hæmorrhage.—Wounds.—Wetherby, of New York, records a very severe case of bleeding from the tonsil (cases which are specially anxious, on account of the proximity of the carotid) completely controlled by the application of Monsel's solution (*Ranking*, ii., 1866); and I have seen instances in which a large vessel must have been wounded by an incision in the tonsil, effectively treated by the local use of tincture of the perchloride; it should always be tried before more serious measures are commenced. As styptic applications to the bleeding surfaces of wounds, iron compounds are not so suitable as some others, because they necessarily prevent union by “the first intention,” and they leave a coagulum, on the separation of which hæmorrhage is apt to recur,—this applies especially to the condition of hæmophilia. Maisonneuve, however, performed some of his boldest operations with their help; thus, he removed a growth occupying half the face and head and involving numerous vessels, applying perchloride on pledgets of charpie at almost every stroke of the knife, and so that the weakened boy lost but little blood; a brown eschar formed, and separated about the twentieth day (*Med. Chir. Rev.*, ii., 1856). Bourgade applied perchloride to the bleeding surface immediately after all operations—calculating to render them by this means “as painless and as safe as if caustic had been used instead of the knife”—both as a styptic and to pre-

¹ The original Monsel's solution was made with persulphate, as described by him (*Recueil des Mémoires*, t. xvii., 1856, quoted by Buisson).

vent septicæmia; the application was painful for a few hours, but not much pus formed, and granulation occurred in a healthy manner; he reports ninety-five cases (Union Méd., 1867). The perchloride is still thus used sometimes in operating upon soft tissues in anæmic subjects when hæmorrhage is likely to be serious. I have seen it applied in the removal of a cancerous tongue and of a cancerous breast, and also in a thigh amputation, but in each case secondary hæmorrhage occurred, and I was not at all satisfied with the action of the styptic; further, it is not free from risk of causing embolism.

Hæmoptysis.—In various forms of hæmoptysis, phthysical and otherwise, preparations of iron are useful if active febrile reaction is not present, and if the blood tension be not high or increased by it (*cf.* B. M. J., ii., 1900). For internal use I prefer the acetate or sometimes the sulphate to other preparations, and they are especially indicated in the passive hæmorrhage of anæmic weakly subjects (of the acetate, I give the tincture in 5 to 20 min. doses every half-hour to two hours). Caution is needed as to their internal use in phthisis, but their local use in spray or powder is advisable whenever the loss is severe or alarming. A striking case, in which death seemed imminent, and in which the insufflation of powdered sulphate at once and permanently controlled the bleeding, is given by Wetherby (Ranking, ii., 1866). Brondgeest (Brussels) treated successfully three phthysical cases by an atomised spray containing the perchloride (Bull. de Thérap., 1866), and Cornil has related similar results.

I have treated several severe cases with satisfactory results by an "iron spray" containing either $\frac{1}{4}$ part of liquor ferri perchloridi, or 1 to 2 gr. of sulphate in the ounce of glycerin and water. It might be thought that blood thus coagulated *in situ* would increase a tendency to congestion of the lungs or chronic pneumonic phthisis, but practically I have not found it do so.

Epistaxis.—When this occurs frequently in patients already anæmic, or when the amount of blood lost threatens to bring on anæmia, iron will be found of great value, and especially in the form of acetate or perchloride: it should be commenced as soon as possible while the hæmorrhage is going on, and continued for some time after it ceases. Several severe cases recovering under 10 to 15 min. doses of the liquor with glycerin and ice water, given every one to three hours, are reported (B. M. J., i., 1898), and Dr.

Hale White speaks well of Jss and Ji doses of the same as a long established treatment at Guy's Hospital (*ib.*, ii., 1898). I have seen this treatment useful in the severe epistaxis of habitual drunkards; it is not, however, always safe for epistaxis occurring in the old, or those disposed to apoplexy.

Hæmatemesis.—I have frequently treated this form of hæmorrhage successfully by means of the perchloride of iron given internally; it has a direct local styptic effect, and in some aggravated cases of gastric ulceration, when the hæmorrhage has occurred frequently, it has arrested it at the time, apparently prevented relapse, and certainly lessened after ill-effects, such as anæmia. Mr. Jones gave Ji of the tincture in Ji of water (B. M. J., i., 1872). Iron alum (a double sulphate of iron and ammonia) is also very valuable in this and other forms of internal hæmorrhage (Lancet, i., 1871).

Intestinal Hæmorrhage.—The perchloride is often useful in hæmorrhage from the bowel, and I have known it answer well. Several cases somewhat obscure in character, but recovering under it, are given in Bull. de Thérap., 1877. The ordinary cause of such hæmorrhage is either cirrhosis of the liver or ulceration of the intestine, and I do not think iron suitable for the former condition, but in the latter it is indicated, since we know that it relieves hæmorrhage from gastric ulcer. In the diarrhœa and hæmorrhage of enteric fever benefit has sometimes been derived from its use.

Hæmaturia.—The internal administration of perchloride of iron is not desirable in acute renal congestion, but I have occasionally met with chronic recurrent hæmorrhage apparently from the kidney, the subjects of which were anæmic and suffering from chilliness, nausea, faintness, etc., who received much benefit from the perchloride. The dose should be from 15 to 30 min. every six hours, and its efficacy may often be increased by 2 gr. doses of ipecacuanha powder, given midway between. A very successful case illustrative of treatment by the perchloride is reported by Vigla (Gaz. des Hôp., 1858). In urethral and vesical bleeding the same treatment is very serviceable, and in the latter malady iron injections into the bladder have been employed with advantage, but the solution must be weak, for if rapid coagulation of blood in large lumps within the viscus were produced, the effects might be worse than those of the hæmorrhage itself.

Purpura.—Scorbutus.—Iron has sometimes succeeded well in purpura of passive character, but it is not of much advantage in the bleeding of true scorbutus. Both the sulphate and the perchloride have cured purpuric cases when other remedies, such as sulphuric acid and change of diet, have had no effect. Homolle was the first physician to recommend the sulphate (*Union Méd.*, 1856), and Dauvergne, recording a striking instance of benefit from the perchloride, remarks that it acts better in cases with large effusion (in plaques) than in the merely petechial forms, and this I believe from my own experience to be correct (*Bull. de Thérap.*, 1867). Other cases may be found in *Bulletin*, 1868, *Brit. For. Rev.*, i., 1861, and *Med. Times*, ii., 1861; they include one patient at seventy, and one a child; in one the malady was connected with deficient supply of animal food; the *arsenate* answered well in another case (*Lancet*, ii., 1872). On the other hand I consider that a too early recourse to iron has sometimes aggravated the hæmorrhage.

Chronic Uterine Hæmorrhage.—All cases of this kind must be carefully considered before resorting to medicinal or local styptic treatment. In a large number iron is highly useful, but it must not prevent the proper surgical management of, for instance, retained placenta or fibroid growth, nor the depletive treatment of a congested uterus. In menorrhagia occurring in the young or the delicate, and accompanied with a generally lax anæmic condition, and often with intercurrent leucorrhœa, the sulphate or perchloride are suitable as internal medicines; the former, with sulphate of magnesium, is especially good. The excessive loss, as well as other and general symptoms which often occur at the *climacteric period*, may be also relieved by these remedies.

Uterine Cancer, etc.—Simpson knew the value of the perchloride in relieving the hæmorrhage and discharge of cancer, and French surgeons equally proved it. The liquor ferri perchloridi fort. is exceedingly serviceable, as shown by Dr. Gibb, of Newcastle; he either filled the vagina with a dilute solution for a few minutes, or plugged with tampons, or painted the strong liquor on the affected part, and so far relieved bleeding and pain, and improved the local condition, as to give, at least, a period of comfort (*Lancet*, ii., 1874). I have made the same application with excellent results, and constantly use in cancerous cases a

plug of lint or cotton wool soaked in a solution of liquor ferri perchlor. fort. and glycerin (equal parts) and firmly pressed against the uterine surface, the vagina being filled with wool soaked in glycerin. Another method is to apply the saturated solution of perchloride to the affected surface on a uterine probe wrapped with cotton wool; this is best in cases when the vagina will not tolerate the presence of tampons, but radical operations are now more usual than formerly.

In cancer other than uterine its application is also valued by myself and many observers, independently of its power as a hæmostatic; it constricts and modifies the affected surfaces, inducing a less rapid growth. Iron cannot cure cancer, but the accompanying debility and the anæmia may be much relieved by a course of it.

Villous Growth.—A severe and obstinate menorrhagia dependent on this cause was successfully treated by Breslau with an intra-uterine injection of equal parts of liquor ferri (Bavarian) and water; it was made through a catheter, left only one minute and then withdrawn (1858). This was one of the earliest cases of the kind, and illustrates a method which I have sometimes employed with advantage; but a more modern and often a safer practice is to curette the lining membrane.

Fibroid Tumour.—If the patient is suffering from marked anæmia and from continued loss when she first applies for advice, considerable relief to the symptoms may be given for a time by the internal administration of the perchloride, especially when combined with ergot; it may possibly be required as a styptic to the cut surface after incision of the cervix; in cases of emergency, plugging of the vagina with saturated tampons is a valuable temporary resource.

Puerperal Hæmorrhage.—The local application of this remedy has not been neglected in this—perhaps the most anxious form of hæmorrhage with which we have to deal. Sometimes the use of plugs or tampons steeped in the solution and packed in the vagina has seemed the best mode of treatment, but it is not free from risk, for it may only conceal serious internal hæmorrhage, and, moreover, the prolonged contact of strong preparations, even though at the time painless, has been followed by serious loss of substance, and permanent contraction and cicatrix (Gaz. des Hôp.,

1869). In post-partum hæmorrhage the rapid application of a saturated sponge to the interior of a non-contracting uterus has proved efficient (Barnes), but the contact of a strong solution so quickly corrugates the membrane of the vagina and the os uteri as to cause difficulty in carrying it far enough, or in withdrawing it (Braxton Hicks).

Intra-uterine injections.—Few surgical procedures more widely and earnestly engaged professional attention some years ago than the intra-uterine injection of strong ferric solutions. Schreier of Hamburg was accustomed to use weak injections ($\frac{1}{2}$ to 1 dr. in 4 oz. water) for hæmorrhage, either before or after delivery, still weaker injections (1 dr. to the pint) having long been practised in the Vienna school, if cold and ergot failed. Ford recorded the successful arrest of severe hæmorrhage after abortion by intra-uterine injection of ferric sulphate (1 dr. in 4 oz. water), also three other cases (Amer. Journ., 1868). Probably other instances might be found, but general interest in the subject was first thoroughly aroused by Dr. Barnes. The mode adopted by him was to mix $\frac{1}{2}$ pint of the liq. ferri perchlor. fort. B.P. with water up to 1 quart, and to inject this slowly through a Higginson's syringe, of which the delivery pipe was passed well to the fundus uteri; by this plan he was satisfied that life had been saved several times, and he held it specially applicable to cases when contractile power could not be aroused, and the uterus remained dilated and inert after a prolonged labour. The styptic mechanically stayed the hæmorrhage by sealing the vessels, and usually induced also uterine contraction (Med. Times, i., 1865; Lancet, i., 1862; B. M. J., ii., 1873). Dr. Hugh Norris recorded a similar experience about the same time (B. M. J., 1869-70). Cases for and against were soon reported from different parts of the country, and it was not long before a vehement controversy arose. A case of secondary hæmorrhage really dependent upon retained placenta, but in which several injections of perchloride solution (the last one being of the strong and undiluted tincture) had been practised, died ultimately of septicæmia, and furnished the text for a full discussion at the Obstetrical Society. Such a case was not really illustrative of Dr. Barnes' mode of treatment, and although it proved fatal, the opinion of practical and experienced accoucheurs was expressed decidedly in favour of such injections in suitable

cases (Lancet, i., 1873). On the other hand instances were referred to in which such injections did apparently cause septicæmia and embolism. In Dublin, the favourable experience of Dr. Barnes was amply corroborated by Dr. Lombe Atthill, whilst Dr. E. Kennedy took a much more cautious view, and urged the reservation of the method for a *dernier ressort* (Dub. Journ. Med. Sci., 1874).

In Edinburgh, the discussion on an unsuccessful case showed a balance of opinion against the procedure. Dr. Matthews Duncan especially questioned its propriety, though Dr. Alexander Simpson expressed a more favourable view (Edin. Med. Journ., 1875). In France, if we may judge by the observations of M. Budin of the Maternité, professional opinion was decidedly adverse (Bull. de Thérap., 1876). In Germany ferric injections seem to have been scarcely tried, those of hot water being preferred.

It is within my own experience that iron injections have sometimes been employed far too soon, from over-anxiety to stay what I should consider not excessive hæmorrhage, which would have yielded, I believe, to cold, or the injection of hot water, and the judicious use of ergot. I am also cognisant of at least five cases in which death has followed apparently from embolism, and yet I do not blame the principle of the treatment so much as some defect in carrying it out. Thus, sometimes the uterus has not been properly emptied of clot beforehand; sometimes the solution has not been strong enough, and at other times the exit has not been free: the greatest care is required as to all these points. The patient should be on her back, the womb emptied of clot and gently compressed, the uterine tube should be long enough (about 9 in.) to reach to the fundus, the solution should be of about 2 oz. dry perchloride to 12 oz. water, or 2 oz. liquor ferri perchloridi fort. to 10 oz. water, free from air, and injected slowly and steadily, and the os must be patulous, and the exit quite free, so that no undue pressure or distension should force fluid into open vessels or through the Fallopian tubes. If these precautions be all adopted, I believe the ferric injections may be used with safety; but of late years the injection of *hot* water into the uterus has been found to be as efficacious as solution of iron and devoid of its dangers, and promises to entirely replace it in practice.

Injections in Aneurism, etc.—About 1852 a method was advocated for the treatment of aneurisms by injecting solutions of

ferric chloride into their sac ; this method met with some acceptance, but before long was entirely discarded.

I think that scarcely sufficient importance has been attached to some of the successful cases—notably to one of aneurismal tumour of the orbit—recorded by an American surgeon (Brainard, *Lancet*, ii., 1853). The ligature of one carotid had given only temporary relief, and the actual cautery still less, but a complete cure resulted from several injections of the lactate of iron (8 gr. to 1 dr.). Brainard considered this salt more suitable than the perchloride, as acting more slowly, and with less irritation or tendency to suppuration. Bribosia (Brussels), in a special treatise on the use of coagulant injections, considers them best adapted for such aneurisms as contain more liquid blood than fibrin, and are situated on the smaller arteries (*e.g.*, those of the cranium), and not too near the trunk. The general opinion of modern surgeons is, however, adverse to the use of the perchloride as a coagulant in aneurism. Marsacci, Gross and Erichsen discouraged it, though the latter cured with it a gluteal aneurism after some suppuration.

Nævus.—Erectile Tumour.—The application of ferric injections to these cases, though often successful, was soon found to require as much caution as in the more serious malady of aneurism ; indeed, in a few cases situated about the face, immediate death resulted, this being sometimes due to a clot formed in a large vein (*Archives de Méd.*, 1868 ; *Lancet*, ii. 1867).

Varix.—I have frequently known a marked improvement in varices while patients were under a regular course, for other affections, of 15 to 30 min. of the perchloride of iron three times a day. To judge by the recorded results of iron *injections* in varix, a large amount of success has been obtained with much less risk than in the last-named diseases ; but yet the method is not generally approved.

Hæmorrhoids.—The perchloride is not only frequently of service as a styptic injection into the rectum to relieve bleeding from internal hæmorrhoids, but has been used sometimes by direct injection into the tumours, and has cured when other expedients have failed (*Dub. Journ.*, 1874). Monsel's solution succeeded equally well in two cases of large external piles (*Med. Press*, 1869). Hæmorrhoids occurring in anæmic or debilitated patients with

copious bleeding, are in my experience often well treated by the internal administration of the perchloride.

Relaxed and Discharging Surfaces.—Relaxed Throat, etc.—The liquor ferri perchloridi, with a little glycerin added, is a good astringent locally and internally in catarrhal sore throat, and in relaxed conditions of the fauces with increased mucous secretion; also in the œdematous, honey-combed condition which remains after follicular tonsillitis, or more serious inflammations of the throat.

Leucorrhœa.—In catarrhal and relaxed conditions of the vaginal mucous membrane, injections containing about 1 dr. of the tincture, or 10 gr. of sulphate of iron in each $\frac{1}{2}$ pint of water, are often useful, but they have the drawback of staining linen. When the leucorrhœa is mainly dependent upon general debility, the internal administration of iron is often sufficient to relieve, without any injection; and in severe cases, occurring in anæmic and cachectic females with œdematous swelling (from excessive losses of blood), I have found the citrate of iron and quinine useful. Montgomery commonly recommended the pernitrate for leucorrhœa.

Spermatorrhœa.—For seminal losses occurring in the young and the debilitated, tincture of iron is of great use; it should be given in full doses twice daily, and preferably not at night; plenty of outdoor exercise should be conjoined.

Enuresis.—When this occurs in strumous children, or in those affected with worms, the perchloride or phosphate of iron gives ready help. One teaspoonful of Parrish's food twice daily, in water, is an excellent remedy for the nocturnal as well as the diurnal form when arising from irritability of the mucous membrane of the bladder. The alternation of iron with tincture of belladonna, or bromide of potassium, acts still better if there be much spasm of the sphincter, and combination with ergot has also succeeded well (Guimaud, *Bull. de Thérap.*, v., 63). Da Costa strongly recommends the bromide of iron in this malady.

Vesical Catarrh.—Iron taken internally has proved of great value in catarrhal affections of the bladder, but it acts chiefly by improving the general health. The carbonated iron waters of Schwalbach are especially recommended (Schmidt's *Jahrb.*, 1877), and are certainly less irritant than the acid preparations. In cases

of catarrh and hæmorrhage following the injudicious use of the catheter, weak injections of tinct. ferri perchloridi, retained for about half a minute, check the hæmorrhage and improve the catarrhal condition (Med. Times, ii., 1870 ; see also Hæmaturia). Other instances of the value of iron in vesical catarrh are reported by Vigla (Med. Times, 1857-58).

Skin Diseases.—In congestive and exudative forms of skin disease much benefit may be obtained from the tincture of iron ; thus, severe *pruritus* may be relieved by it (Lancet, ii., 1874). In a case of chronic infiltrated *eczema*, when tarry preparations had failed, painting with the tincture, and afterwards with collo-dion, not only cured the intense itching, but also the malady itself, leaving only a dry and brown, but sound skin, and I have seen a case of pityriasis rubra in which the intensely red, dry and scaly condition was more relieved by the application of this remedy combined with glycerin than by anything else. *Lichen agrius* is also relieved by it. Devergie drew attention to its value in chronic pustular disorders, such as *rupia*, *ecthyma* and *impetigo* or *pustular eczema* (Med. Times, ii., 1860), in which it may be locally applied as well as taken internally. It is a good application for *variolous pustules* (Med. Times, ii., 1856 ; Ranking, ii., 1866), and has favourably influenced the course of *anthrax* ; a striking case is reported by Dauvergne (Bulletin, 1867).

Herpes.—Baudon found immediate good results from painting the vesicles of herpes with tinct. ferri perchlor. and glycerin ; he recommended opening the larger vesicles for the application, but Gressy obtained equally good results without opening them, using a concentrated alcoholic solution, which gave rapid relief (Bulletin, t. lxiii.). An ointment containing 6 to 10 gr. of sulphate of iron in the ounce is recommended by Palmer (Med. Times, ii., 1861).

Ringworm.—The local use of iron in ringworm is an old practice, which has been revived. After cleansing the part, tincture of the perchloride may be painted upon it three or four times, at a day or two's interval ; a brown scale forms, which should be left undisturbed—glycerin will lessen the sense of dryness and constriction. I have found this treatment succeed in slight and recent cases ; also in old ones, after more active remedies had been used, and it has the advantage of being not unpleasant.

Onychia.—In-growing Nails.—Successful results have been obtained by using the perchloride locally; for instance, a delicate girl who had suffered for several years, and undergone removal of the nail and ordinary modes of treatment without relief, was cured mainly by the use of an ointment made with perchloride, and a few applications of the solid compound; the latter gives pain and requires to be almost immediately washed away (Bulletin, 1853). The persulphate has been used in other cases (Med. Times, ii., 1868).

Ulcerations.—In chronic indolent ulceration the perchloride is a good stimulant; also the carbonate, finely powdered, has been applied in substance to old and excavated ulcers of the leg, and with good bandaging has succeeded well (Lancet, i., 1862). The salicylate of iron is said to make a useful lotion (Edin. Med. Journ., 1877).

Phagedænic Ulceration.—The combined internal and external use of tinct. ferri perchloridi was advised by Ricord (Med. Times, i., 1859). Roget adduced instances of it curing chancre when applied early, and he maintained that the local use of an acid solution directly after exposure would prevent gonorrhœal, and even syphilitic contagion (Traité sur le Perchlorure de Fer, 1860, Paris). Rabuteau speaks favourably of the remedy—substituting only citric acid for the more irritant hydrochloric. He adopts the following formula: R. Tinct. ferri perchloridi (30° Beaumé = 0.879 sp. gr.), 12 grammes; acidi citrici, 4 grammes; aquæ, 24 grammes; solve f. lotio.

Hospital Gangrene.—The perchloride and Monsel's solution have been largely used as local applications, especially in military practice. Salleron gives a very favourable report of these from experience in the Crimean hospitals and elsewhere (Buisson, Traité, etc., and Med.-Chir. Rev., ii., 1860). A "gangrenous throat" was also treated successfully with perchloride (Med.-Chir. Rev., i., 1861).

In **Erysipelas** preparations of iron have been used, both externally and internally. A strong ointment or lotion of the sulphate (about 1 in 4) was recommended by Velpeau after many comparative trials with other remedies; it does not, however, always prevent the extension of the inflammation (Bulletin, 1855). Mr. Hulke recommended a lotion containing

10 gr. in the ounce (B. M. J., ii., 1871). The application of equal parts of liq. ferri perchloridi and spiritus vini rect. would seem still more valuable (Oswald White, B. M. J., i., 1876); and Mr. Foster of Leeds obtained so much success by painting the ordinary tincture of perchloride over erysipelatous surfaces that this plan became known as the "Leeds method"; it was applied also to inflamed lymphatics, breasts, etc., and seems to have been especially useful in erysipelas after vaccination (Lodge, Med. Times, i., 1875). Mr. Hamilton Bell was the first to publish cases of remarkable benefit from the *internal* administration of the same remedy, or rather of the old "tincture of muriate of iron"; he gave 20 to 30 drops every three hours, so that sometimes 2 oz. were taken in eight days (Edin. Month. Journ., 1852). In severe cases of "idiopathic" erysipelas the spread of inflammation was arrested, the pulse lowered and the fever relieved, and equally good results were reported by Balfour, Begbie, and other eminent men; but although Lehmann writes more recently in praise of the treatment (Lancet, i., 1880), we cannot concede to iron the "specific" virtue in erysipelas that has been claimed for it, nor is it the best remedy for every case. Todd denied its efficacy; and H. Bennett and Estlander found it useless in traumatic cases (Med. Times, ii., 1860-71).

Aren, commenting on ten satisfactory cases recorded by Mathez (Thèse, Paris, 1857), points out that iron is not the best remedy for young, robust subjects with high fever. It is fair to add that Mr. C. Bell still maintains its very great value in all forms of erysipelas, and attributes the failures of other practitioners to the use of too small doses, or of less excellent preparations; he states that under his own care patients have recovered so soon as the old "tincture of muriate" was substituted for the modern "perchloride." The former, made with sesquioxide and hydrochloric acid, contains more free chlorine and some protochloride of iron, but the present tincture of the B.P. is a more definite preparation (Edin. Med. Journ., 1876). Some practitioners have sought an indication for iron in the locality affected, finding it least useful for erysipelas of the head or trunk; but Pirrie has obtained the best results in such cases. I think that in choosing a remedy for erysipelas we should look rather to the general constitution of the patient, the nature of the tissues affected, and the character

of the inflammation ; thus, I find iron to be really the best remedy in anæmic, weak patients, or in lymphatic constitutions when there is rapid extension or flitting of the inflammation, when the affected surface is dark-red or bluish, when the pyrexia is slight, and when, owing to debility, the attack tends to linger.

In the erysipelas consequent on surgical operations it is also useful if the subject has been reduced by long-continued suppuration or other causes of exhaustion. I believe it has also some prophylactic power.

Diphtheria.—This malady through its streptococcal factor has been successfully treated by the same preparations of iron both locally and internally. Some of the earliest observers recommended the application of perchloride to the seat of exudation, on the ground of the effused membrane being parasitic, but other physicians discouraged the use of such local means as might irritate ; Trousseau, for instance, was disappointed in a strong tincture of perchloride used “as a caustic,” and such application is not to be recommended ; his remarks, however, do not apply to the use of a more dilute form, and I have always found that judicious local disinfection was very important ; various remedies may serve, but the gentle application of diluted ferric solutions has given very good results in competent hands. Dr. Nelson (New York), after ample experience of several methods of treatment, expresses the strongest conviction in favour of local applications of Monsel’s solution (liq. ferri subsulphatis) diluted with glycerin and water ; amongst forty cases thus treated he had only three deaths (New York Med. Journ., 1874). Dr. Billington, in an excellent practical essay maintaining that diphtheria is at first a local affection, held that it could be treated most successfully by early local disinfection ; he used lime-water, carbolic acid, etc., but gave a decided preference to the tinct. ferri perchloridi, 2 parts to 1 of glycerin ; this he painted especially over the tough adherent membranes, and all adjacent parts. Three hundred cases treated upon this principle showed a large percentage of recoveries, and other physicians corroborated Dr. Billington’s results (New York Med. Record, 1876).

Bertheau describes a severe epidemic of “diphthérite” affecting 220 people (Indre), in which the most useful of all the means

employed was the local application of tinct. ferri perchloridi (30° Baumé); when the membrane was unusually thick, this was painted on three or four times daily (Du Traitement de Diphthérie, etc., Paris, 1876). Dr. Fera applies the finely powdered sulphate of iron freely to the affected part, and attributes to this the successful termination of eighty cases, whilst De Sabbata speaks in equally favourable terms of the use of an acid solution of the same salt (Lond. Med. Rev., 1876). Löffler's pigment for diphtheria consists of menthol 10 parts, toluol 26 parts, solution of ferric chloride 4 parts, and absolute alcohol 60 parts.

Referring to my own experience, I find detailed notes of twenty-seven consecutive cases of diphtheria, in which the perchloride was used locally or internally; for the local application I employed an atomiser with equal parts of the solution and water, and continued its use for about five minutes every one to three hours. In six cases no internal medication was ordered, but besides using the spray, the throat was swabbed out with solution of perchloride mixed with an equal part of glycerin, two or three times in twenty-four hours, but this is often very distressing to children. The age in these six cases varied from five to nine years, and five of them recovered; but the attack lingered longer, and its course was more unsatisfactory, and convalescence more tedious than in other instances when internal treatment was conjoined; one child, aged four years, had nasal diphtheria and sank on the third day. In another series of six cases, including children of from two to seven years, I gave iodide of mercury ($\frac{1}{30}$ to $\frac{1}{40}$ gr.) and also liquor arsenicalis, and used freely a spray of perchloride of iron locally, and these six cases did well. The remaining fifteen, varying in age from two to ten years, were also treated by the spray, and in addition they received from 5 to 10 min. of the liquor ferri perchlor. every one or two hours, and of these cases twelve recovered. Nine of the total number had albuminuria on being first seen by me, and three hæmaturia; another had severe epistaxis, and all showed much exhaustion, with more or less dyspnœa and delirium. The iron given internally seemed to exert a sedative effect on the circulation, lowering the frequency of the pulse, and rendering it more full and forcible. I have never seen hæmorrhage, or albuminuria, or congestive symptoms of any kind which could fairly be traced to its action, and am satisfied that its effect on the

course of the disease is beneficial, though we cannot, any more than for erysipelas, consider it a "specific."

Admitting, however, that twenty-seven cases do not furnish sufficient basis for a positive conclusion, it will be desirable to review briefly the experience of previous observers, which will be found to be much in favour of the iron treatment. It was strongly recommended to the profession in 1857 by Aubrun, in France, and soon after by the late Dr. Heslop in this country (1858-59). The mortality before that date was most severe—thus, of twenty-six cases related by Aubrun, and treated without iron, twenty-two died. In the next series of cases, in which he used the remedy both internally and locally, out of twenty-seven three only died, and in another series of twelve cases there were no deaths at all (*Gaz. des Hôp.*, 1859); nor does it seem that any natural lessening of virulence in the epidemic accounted for this striking difference.

Aubrun was most particular in his method of administration, ordering one or two teaspoonfuls of a solution every five to fifteen minutes through the day and night, for the first three days of the attack, "because usually membranes would be detached, or would cease to form after that time"—then the medicine could be taken less frequently (*Comptes Rendus*, 1860). Da Silva, commencing with only the local application of perchloride, soon found improved results from using it internally, and recorded many successful cases (*Gaz. des Hôp.*, 1859). Isnard was a still more earnest advocate for this treatment. He reasoned also that it might prevent exudation just as it might hæmorrhage, rendering the blood more plastic, and whilst acting as an alterative on the mucous membrane of the respiratory tract, it was better than alkalies, for they were too slow in action and too lowering; it should be given, he held, early and repeatedly so as to influence the condition of the blood as soon as possible; in support of his reasoning he adduced thirty-nine cases, of which thirty-five got well without operative interference, and two after tracheotomy. Dr. Heslop, after referring to the then excessive mortality of diphtheria and the failure of all accepted modes of treatment, recorded several striking cases of recovery from almost hopeless conditions under the internal use of the tincture of the perchloride; he conjoined with it local applications of dilute hydro-

chloric acid. Mr. Pound related equally good results, and Mr. Houghton (Dudley) contributed four striking cases of recovery under very unfavourable conditions. Mr. Fisher attached much importance to the use of a preliminary emetic or purge, and Sir George Johnson, agreeing that treatment with the perchloride internally was the most successful of all, conjoined with it local chlorine applications (*Lancet*, i., 1875). The appearance of albumin, blood, or tube-casts in the urine does not contraindicate the use of iron in this disease, but on the contrary calls for its administration, and preferably with nitric or hydrochloric acid; under the same conditions stimulants should be judiciously regulated, but seldom withdrawn. Diuretics are injurious, but as a rule demulcents should be freely taken. Patients should be well nourished with beef-tea, soups, eggs, milk in any form, chicken panada, etc., and ice sucked or swallowed is agreeable and relieves the painful condition of the fauces; the skin should be kept clean and warm, and the house and room well ventilated; aperients as a rule weaken the patient and cause an extension of the exudation in the throat.

The treatment by antitoxin has now largely superseded that by drugs, but it is not always available.

Scarlatina.—Scarlatinal Angina.—Variola.—In many of these cases I have used the perchloride internally, and applied it to the throat mixed with equal parts of glycerin and water, or through an atomiser, with satisfactory results, but I recommend it most in cases which assume a malignant or putrid form; benefit is often obtained by painting the swollen cervical glands with the liquor ferri perchloridi.

I have treated many cases of articular inflammation occurring during scarlatina, and closely resembling articular rheumatism, showing high temperature and great prostration, with 5 to 10 min. doses of the tincture of the perchloride three or four times daily, with excellent results, the joints being also painted with the liquor. Meade recommends the same medicine in frequent doses of 10 to 15 min.; and Arlidge believes it to be not only valuable as a remedy during the attack, but as a preventive of drowsy (B. M. J., ii., 1871). Fears have been expressed—as in the case of diphtheria—of its increasing renal congestion, but I have never seen injurious effects which could reasonably be traced

to it, and Dr. Crichton makes the same observation (B. M. J., i., 1869). He considers that any risk of this kind may be obviated or lessened by combining liquor ammonii acetatis with the iron compound, thus assisting the action of the skin, and making the form of the iron (the acetate) less irritating to the kidney, and I believe the combination to be very serviceable in febrile and inflammatory cases. Dr. Reed states that a good preparation may also be made by mixing half a drachm of citrate of potassium with every drachm of the tincture (Pract., i., 1882).

The latter has sometimes been used with good effect to relieve the throat condition in variola (Med. Record, 1873), and the course of the malady itself seems to have been favourably modified; $\frac{1}{2}$ dr. doses of the tincture were given every four hours in a severe case occurring in the seventh month of pregnancy, and the patient did well (Ranking, ii., 1866). In typhoid fever the perchloride has been used with some success (B. M. J., ii., 1891).

Rheumatism, Acute and Subacute.—To estimate the value (or the reverse) of iron in acute rheumatism I must refer rather to the experience of others than to my own. Pétrequin seems to have been the first to use it, and reported marked advantage from doses of 40 to 80 min. given in the course of twenty-four hours; he prescribed it with lemonade, and made trial also of the sulphate and the citrates (Eaux Minérales, Thèse, Paris, 1855). Sir Russell Reynolds—led to use the remedy by consideration of its value in erysipelas—brought before the profession a series of eight cases in which the average duration of high temperature was shortened (to five and a half days as against fifteen), and in several of which pain was quickly relieved and no discomfort produced; but, on the other hand, one patient died comatose after delirium, and another of pneumonia and pericarditis, whilst a feeble or intermittent pulse of 56 to 60 caused anxiety in two of the others; most of these patients had some cardiac inflammation before coming under treatment, yet the results can scarcely be considered favourable (B. M. J., ii., 1869). In another series of cases he had more success; thus, out of a total of sixty-five, 44 per cent. of first attacks were convalescent in the course of a week, and most of those suffering from second, third, or fourth attacks in the second week; one-half of the whole number were severe cases, yet the temperature became normal within fifteen days; hyperpyrexia

occurred in three, and proved fatal in two instances. These results were unsatisfactory, at all events as compared with modern treatment. Three cases of hyperpyrexia out of sixty-five is a high percentage, and many physicians are inclined to think that they were not unconnected with the mode of treatment adopted.

There is much more doubt as to the suitability of this remedy in acute rheumatism than in erysipelas or diphtheria, although when the urine is alkaline and the patient is anæmic and feeble, tincture of steel seems appropriate; also rheumatic pain is often relieved by it, and it is of recognised value in the anæmic condition following acute attacks, and in subacute and chronic varieties of rheumatism. Dr. Anstie drew attention to its power of cutting short subacute cases as observed amongst the out-patients at the Westminster Hospital. In such as were really rheumatic (and not gouty) in character, with sallow patchy face, deep furring of the tongue, oily moisture of the skin, obscure aching of the limbs, slight rise of temperature, and troubled respiration, he found that 30 to 40 min. doses, given three to six times in the twenty-four hours, often arrested the progress and relieved the symptoms in a few days; this occurred in seventeen cases out of twenty-nine (*Pract.*, Sept., 1871). (These observations were made before the discovery of salicylic acid as a remedy for acute rheumatism.) Compounds of iron are now restricted as to their use in this disease to the relief of the anæmia which follows it.

Chronic Rheumatism.—Iron is also useful in chronic rheumatism when the patient is much reduced in strength and flesh after an acute attack; it should be continued for some time, for its favourable effects are but slowly produced.

Rheumatoid Arthritis.—Sir A. Garrod recommends iodide of iron “in some cases of rheumatoid arthritis, especially when the joint-pains are increased by the heat of the bed.” I have tried it, but have seldom seen good results from it.

Anæmia.—The various preparations of iron form our most dependable remedies in ordinary and simple cases of anæmia and chlorosis; and indeed their good effects are usually so evident that iron was at one time considered a panacea for all forms of these affections, but in reality if prescribed injudiciously it may

not only fail to cure but may produce ill results, and observation of such instances has led some observers to depreciate a remedy which had been considered so universally curative. Thus, Trasbot has denied to it "any reconstituent or hæmatinic power, whilst Dujardin-Beaumetz called the employment of iron in anæmia "une grande illusion thérapeutique" (*Journal de Thérapeutique*, 1876). The former observer states that in experiments on dogs he obtained better hæmatinic results from calcium phosphate, coffee and wine than he did from iron, which proved simply exciting; and Dujardin-Beaumetz relies upon an argument of C. Bernard's, that even if the normal amount of iron in the blood of chlorotics be lessened, it is only by a very small amount (10 or 20 centigrammes),—more than that which is introduced daily in the food: but the true answer to such observations is, that all theory and even all physiological experiment must stand or fall by the clinical results obtained in man, and in the majority of cases these are satisfactory. The objections of Trousseau were limited to the use of iron in "false chlorosis"—that is to say, in cases when the suppression of the menses, pallor, etc., were really connected with incipient phthisis, which malady he found to be accelerated by ferruginous medicines (*Traité*, vol. i.). His observations have been corroborated by Millet (*Bulletin*, 1862), but the cases quoted by the latter author illustrate mainly the injudicious domestic use of certain preparations without due examination of the patient, and his remarks apply only to the abuse, not to the medical and proper prescription of the remedy.

Dr. Murrell has recorded the case of a woman aged twenty-nine, suffering from oligocythæmia and oligochromæmia, with the object of showing that organic iron preparations are less efficient than the inorganic. He gave $\frac{1}{2}$ oz. doses of a liquid extract of spinach, grown in a ferruginous soil and containing malate of iron, and at the end of a fortnight she was much improved and both red and white corpuscles were increased in number, but hæmoglobin was rather lessened: 5 gr. of dried sulphate of iron were then substituted for the malate, and at the end of another fortnight the hæmoglobin was much increased, while the number of corpuscles was rather lessened (*Med. Press*, i., 1900). As improvement in hæmoglobin is always slower than in corpuscles the case does not

seem very conclusive, and certainly I have often found organic compounds, such as hæmoferrum, or succinate, or peptonate of iron, in efficient doses, agree better than the inorganic—though no doubt these are more active if well borne.

Some cases of anæmia benefit by iron more than others, and it is not easy to lay down definite rules concerning them. If there be much dyspepsia, this should first be treated by other appropriate means; but, on the other hand, the simple atonic dyspepsia of anæmic persons is very amenable to iron. The headache associated with plethora is a contra-indication, but the pulsating acute headache which follows profuse hæmorrhage really requires iron medication. Important points for securing its good effects are to obviate constipation by aperients if necessary, to secure fresh air for the proper assimilation of the remedy, and to keep the skin active by the use of warm baths; I think that many failures in the treatment of anæmia are traceable to want of management on these points.

Direct anæmia dependent upon excessive hæmorrhage; or the indirect anæmia which follows loss of animal fluids generally (such as in obstinate leucorrhœa, empyema and suppurations, seminal losses, profuse perspiration, diarrhœa, prolonged lactation, or too frequent pregnancies); also the anæmia produced by acute disease such as rheumatism, and that connected with dyspepsia and inanition when the albuminous constituents of blood are really most deficient,—all these forms, though complicated with extreme debility and general hydræmia, may gradually improve with good food, rest and pure air (especially if the cause be removed); but iron, given in suitable doses so as not to disorder the stomach, will greatly assist and hasten recovery.

In other cases the best dietetic measures alone are insufficient, and iron is indispensable for cure; in the congenital anæmia of children born after profuse uterine hæmorrhage, or whose parents were affected with anæmia, tuberculosis, constitutional syphilis or other exhausting diseases, iron is of special value; also in strumous and rachitic cases (when the iodide or the phosphate is the most suitable form), but it requires to be continued for a long time. I have always found in the treatment of simple anæmia that when under the judicious use of iron the blood assumes a healthy aspect and the formidable symptoms disappear if the iron medication is

not persevered with, for even a considerable time longer, the malady returns in an aggravated degree.

Anæmia arising from severe and continuous mental strain is best treated by the phosphate conjoined with cod-liver oil—many cases have come under my observation when this treatment proved highly beneficial. In the anæmia due to mal-hygiene, to sedentary pursuits, prolonged residence in a town atmosphere, or continued exposure to carbonic acid, iron compounds are also markedly useful. In all these forms their advantage has been often verified by the enumeration of the blood-corpuscles, and estimation of the amount of colouring matter.

In the so-called "*pernicious*" anæmia, iron, at least in the forms usually employed, has no remedial power; arsenic, and perhaps phosphorus, have succeeded better (*v. p.* 508). Benefit has, however, been reported even in this malady from the *hypodermic* use of iron. Oral and intestinal antiseptics is an important part of the treatment of this disorder, as shown by Dr. W. Hunter and others.

In ordinary *goitre* iron alone is inefficient, and in *exophthalmic goitre*, although anæmia is commonly a marked symptom, I have seen disadvantage from it,—it has often increased headache, though it may be suitable in some cases. In the anæmia of incipient phthisis it must be given with caution; and in that connected with diabetes and malignant or malarious disease, its effects, though often good, are uncertain.

It is worth while, even at the present time, to refer briefly to two of the earliest facts which fixed the value of iron in suitable cases of anæmia. An epidemic malady, apparently unknown at the time (1804), attacked the workers in the coal mines of Anzim: it was probably anæmia from carbonic acid poisoning, for they became pale, feeble, short of breath and died of asthenia or chest disease. Treatment by quinine, opium, good food, etc., failed to relieve, and four cases were sent to a hospital in Paris for the opinion of the physicians; of the four men, one died shortly, and at the section, Hallé noticing the exsanguine appearance of the body, thought of iron and prescribed it for the others, who got well, and returning home cured their companions with the same remedy (Quevenne, *Mémoire*, etc.). Something similar occurred at the metal mines of Chemnitz, where the workers at

one time died rapidly with "anæmia, asthma, phthisis and dropsy," till the epidemic was stayed with iron medicines by Hoffinger (Ozanam, *Histoire des Epidémies*).

Chlorosis.—The relationship of chlorosis to anæmia is not exactly clear, but it has this in common with it—that the number of red corpuscles is diminished, and all are pale-coloured; the blood plasma forms a larger proportion of the blood than natural; after the blood has clotted and contracted, the clot is found to be small owing to the small number of corpuscles entangled by the fibrin, and therefore the serum appears to be more abundant than usual; the amount of hæmoglobin is always notably diminished, and in much greater degree than is proportionate to the lessened number of corpuscles. Thus, with a reduction of 20 per cent. in the latter, there may be a fall of 60 or 70 per cent. in the amount of hæmoglobin. In causation also the malady is allied to anæmia, since it occurs often in young girls obliged to live in close, ill-ventilated rooms or work-shops. It seldom occurs in any but unmarried women, and chiefly from thirteen to twenty-four years of age; if it occurs later in life, it is usually traced to frequent confinements coming rapidly one after another, and especially if the women nurse their children. It is connected with deranged menstruation and certain sexual causes which we are at present unable to distinguish accurately; it occurs either before the menses have appeared, or after symptoms of disordered menstruation have continued for some months; dysmenorrhœa and leucorrhœa are frequent precursors of it. It is often hereditary; the children of tuberculous parents and delicate women with irritable nervous systems are the most susceptible to it; sometimes, in exceptional cases, menstruation is too frequent and profuse. The patient is subject to most of the symptoms already described under anæmia, especially dyspnœa, palpitation, headache, giddiness, and dyspepsia; the face is cedematous and pallid, with a greenish hue; the condition lasts longer than ordinary anæmia, and relapses are still more liable to occur.

Clifford Allbutt makes a main difference to be in the pulse, which is "quick, feeble and empty" in anæmia, but in chlorosis "full and good"; also in the former the heart's action is feeble, in the latter more excited and irritable. Lloyd Jones finds a

difference in the specific gravity of the blood (On Chlorosis). Dr. G. Oliver describes other variations (Blood and Blood Pressure).

The cure of this affection is often readily accomplished with suitable diet, pure air, exercise, healthy mental occupation and a steady course of iron, which latter is almost a specific in simple cases. It was formerly thought that the metal acted by supplying some deficiency in the blood, or at least by directly increasing the number of corpuscles. Béhier considered that it was always indicated when he found, on microscopical examination, that the red discs were reduced to a proportion of 60 per cent. of the normal, and to some extent this is a guide. General improvement will usually occur *pari passu* with an increase in their number towards the normal amount, but it must be understood that the action of iron is not simply a mechanical or chemical one. Claude Bernard has endeavoured to show by analysis that the metal as such is not always deficient in amount in chlorotic blood (but it is), and Hayem has shown that the number of corpuscles is not always diminished before, nor increased after the use of iron; on the other hand, the latter observer has clearly shown that the hæmoglobin is increased, and that the size, colour, and "vital character" of the corpuscles are remarkably improved by it. Others have attributed the benefit of iron in chlorosis partly to its causing some irritation of the intestinal tract which favours absorption of organic iron, and partly to the artificial supply lessening the ordinary destruction of the same in the system (Rev. des Sci. Méd., 1892).

Otto Jallase (Münch. Med. Woch., Sept., 1899) treated a number of chlorotic girls at first by rest in bed and a suitable diet, and later by iron in addition, and found that though the subjective symptoms improved, the percentage of hæmoglobin in the blood remained stationary until iron was added, when it immediately rose, at least 5 per cent. each week. In malarial anæmia, on the other hand, the percentage of hæmoglobin rose steadily after the malaria was cured, whether iron was given or not.

With regard to the preparation that is most suitable, we may refer to the observations of M. Coste. He made trial of different forms in 118 cases, fifty-five being of chlorosis, and he concluded that the choice of any particular one was not in itself important,

if irritation of the stomach did not result—every preparation that did not irritate produced the good effects of iron; the reduced metal taken at meal-times in small quantities proved on the whole the most satisfactory form, and the experiments of Quevenne, and the observations of Chomel, Trousseau and others, are to the same effect.

Professor Stockman says: "Of one thing I feel convinced, namely, that in chlorosis the ordinary inorganic preparations of iron cure much more quickly than organically combined iron does. Patients fed on even a rich and varied diet, containing plenty of organic iron, do not as a rule recover until inorganic iron is administered. I have tested this frequently, and have no doubt that it holds good in the great majority of cases, although some cases of chlorosis do recover spontaneously, and without any treatment—that is on the iron of the food alone."

Buzdygan considers that the gastric intolerance of iron by some anæmic patients depends on hyperacidity. The iron increases the flow of gastric juice and where this is already in excess the dyspeptic symptoms are aggravated. Where it is normal or diminished in amount, iron may do good as regards the dyspepsia present, by stimulating the gastric juice (*Wien. klin. Woch.*, 1897). Sydenham obtained remarkable success with iron filings and iron wine, and, as a rule, we may say that the simpler the form used the better, and chemical theories as to solubility, etc., do not guide as to the therapeutical result. Reduced iron, the dialysed solution, the oxides and proto-salts, especially the carbonate, are certainly to be preferred in the earlier stages of chlorosis, unless the occurrence of mucous or other discharges indicates a necessity for astringents: sometimes the metal itself causes unpleasant eructation, and the oxides are liable to adulteration, and hence the recently precipitated carbonate, which is not astringent or irritant, is preferred by many, and in the form of *mist. ferri comp.*, or Griffith's mixture, has had great repute in the treatment of anæmic amenorrhœa. The "*Pilules de Bland*" contain carbonate of sodium and sulphate of iron, and have for many years retained a high reputation in the treatment of chlorosis, especially on the Continent (Niemeyer): his original memoir recording thirty successful cases is republished by Bayle, and will repay perusal (*Biblio. de Thérap.*, iv., 1837).

The choice of a compound in any case of anæmia or chlorosis seems to me always to depend on the susceptibilities of the patient to the drug. Some are never able to take the astringent preparations even when the alimentary canal is not deranged. Dr. Ringer teaches, however, that the best results are always to be expected from these preparations—either the perchloride or the dried sulphate: the latter being especially useful in the shape of 5 gr. pills two or three times a day. Many patients can take iron only after food; indeed it is always best to give it at this time so that it may be more readily assimilated. In others, again, constipation is produced, though this may be obviated by giving the sulphate mixed with magnesium or sodium sulphate. In those unable to take astringent compounds in any form, one or other of the blander preparations must be employed, such as the citrate of iron and quinine; one of the most valuable of these being dialysed iron. I have had excellent results from the protochloride, and sometimes the citrate with ammonium will be borne better than any other, while in other cases a peptonate or albuminate is preferable, and in the anæmia so common in Japan, and traceable to intestinal catarrh, it was better borne than any other compound. I have seldom seen the astringent forms, when given in a right dose and at a proper time, produce any injurious effect on a weak or irritable stomach; indeed, in many such cases I have found them particularly suitable, and we need not often be deterred from their use by fear of irritating effects: also they should be given in “menorrhagic chlorosis,” for it is found practically better to treat the anæmia in such cases than to omit iron for fear of increasing hæmorrhage (Trousseau). This applies especially to cases where the discharge is profuse and frequent, but pale and coagulating imperfectly; though even when it is florid in character iron may be ordered with advantage, if due attention be first given to such symptoms as hepatic congestion and constipation. Astringent preparations are also useful if there be a tendency to palpitation, general relaxation or undue discharges of any kind, and also when impairment of nervous power is a marked symptom; sometimes very large doses are most successful, thus extremely anæmic girls took a quart daily of a solution gradually increased in strength from 5 to 25 min. and upwards of perchloride tincture to the ounce of water: 30 oz. of the tincture were taken in twenty-seven days

with nothing but good results, an aloes pill being taken daily (B. M. J., i., 1891). Lepine, Gloevecke and others have obtained good results in those cases of severe anæmia which could not take iron by the mouth from its hypodermic or intramuscular injection. The citrate in a 4 per cent. solution has been found suitable (Semaine Méd., May, 1897). Quinke recommends a 5 per cent. solution of the citrate, giving 15 to 30 min. daily ($\frac{3}{4}$ to $1\frac{1}{2}$ gr.); he also uses the peptonate of iron in the same way (Verhandlungen, 13th Germ. Med. Congress). It has also been given per rectum injected into the peritoneum. Aloes is often added to reduced iron or iron carbonate for phlegmatic subjects, and saline aperients to medicines containing iron sulphate, especially if the patient be *plethoric*; sometimes small doses of belladonna will regulate the bowels, preventing constipation better than purgatives. In all cases, success will depend less upon giving a large quantity of the medicine, than upon *securing its due assimilation*, for which purpose air and exercise are important, and fatty food certainly aids the digestion of iron. Jeannel found that an oleo-stearate of iron, prepared with the sulphate and white soap, was very well borne: the chloropeptonate is also good, and the succinate will almost always agree well. Nitro-hydrochloric acid baths favour the absorption of iron.

As already remarked, it is important to continue the remedy sufficiently long, and not to omit it on the first symptoms of improvement; permanent benefit can seldom be expected under five or six months. In cases where iron had not been given successfully, I have found great advantage from *arsenic*, in conjunction with it. Manganese has also been recommended.

Aposte (Pavia) has performed experiments which also seem to show that arsenic increases the number of the red blood corpuscles, while iron increases the amount of their hæmoglobin. He injected into the veins of dogs solutions of arsenic and of iron (Ital. Cong. of Int. Med., October, 1898).

Anæmia of Pregnancy.—We consider iron not a direct, but an indirect emmenagogue, by virtue of its improving the condition of the blood; but since the continued use of the mineral may cause congestion of the pelvic, as well as of other organs, it becomes an important question as to whether its use is admissible or is dangerous during pregnancy. Certainly the perchloride has been in

frequent popular use as an abortifacient, but the evidence of its power for this purpose is not cogent. Its use has often furnished occasion for prosecutions, but few instances of its really causing abortion are recognised, and in many of these, as well as when the sulphate has been used, the effect seems to have followed from violent irritation of the intestinal canal. It is true that cases in which abortion is deliberately produced would not, as a rule, find their way into the press; but, allowing for this, I recognise a general impression gaining ground that iron may be taken during pregnancy without injurious effects. Ramsbotham and Barnes recommend it, the latter stating that he has never seen it do harm (*Lancet*, i., 1874). It was asserted during a trial that 10 gr. doses of ammonio-citrate of iron were dangerous to a pregnant woman, but Dr. Woodman contradicted this from his own experience, and Dr. Graily Hewitt said that he and others constantly prescribed it during pregnancy (*B. M. J.*, i., 1870). Dr. Bassett brought before the Obstetrical Society many cases illustrating the value of the citrate and tartrate of iron in averting miscarriage and serious hæmorrhage in delicate women, and there seems to have been no difference of opinion upon the subject (*Lancet*, i., 1874); he considers that the addition of an alkali to the iron medicine renders it better borne, and points out that aperients should be given occasionally during the course. I can corroborate the experience of Dr. Bassett, and I think that the neutral preparations of iron are the most suitable during pregnancy, though some observers speak well even of the perchloride (*Day*, *B. M. J.*, i., 1870). Trousseau remarks that iron has no direct emmenagogue power, and Hirtz has never seen any objection to using iron in the anæmia of pregnancy, though he has not found it very useful (*Dict. de Méd.*); altogether we must conclude that the older fears of injury from its moderate medicinal use were unfounded.

Phthisis.—A great deal of fear has also been expressed about the use of iron in this malady, and it has been said by eminent observers to hasten and aggravate its course, especially when given in full doses and in the early stages (Trousseau, Millet, *Bull. de Thérap.*, 1862, etc.). If there be acute pyrexia and evidence of pulmonary congestion tending to hæmoptysis, I think that iron is better avoided, because it increases blood-pressure and congestion, and stimulates blood-formation; in any case it should be given

with caution during the early stages of the malady ; special attention should be directed to supplying any deficiency of fatty food, and to securing a due amount of oxygen. Iodide of iron is one of the best preparations to use, and it should be combined with cod-liver oil or other oils. The hypophosphite, especially with quinine and strychnine, has now a special reputation. In *later* stages of phthisis, all are agreed as to the value of iron in relieving many of the most distressing symptoms, and assisting any measure of recovery that can be obtained ; the astringent preparations control purulent formations and discharges of various kinds, such as expectoration and passive hæmoptysis, diarrhœa and profuse perspiration, and they often improve the strength and the appetite. Bonorden used the sulphate in a number of cases, giving from 2 to 4 gr. every two hours for several days at a time ; the dose seems large, but he obtained very good results (Schmidt's Jahrb., May, 1852). Dr. Thompson employed chiefly the perchloride at the Brompton Consumption Hospital, and calculated the effects of iron medication in more than 1,500 cases—54·6 per cent. were found “improved,” 23 per cent. much improved, and only 21 per cent. not improved. He does not give the details of any cases, nor does he mention the stages of the disease when iron was used, but states generally that the patients grew stronger, and were able to eat better, and suffered less from flatulence, diarrhœa, night sweats, and hæmoptysis ; he considers that iron is clearly required in the treatment of phthisis, because “it improves the condition of the blood,” and he advocates its continued but moderate use “as a food.” Others have written special treatises in favour of this medication.

Chronic Bronchitis.—Emphysema.—In chronic bronchitis with profuse expectoration I have found iron compounds, especially the perchloride and the phosphate, often useful ; besides improving the general health, they lessen the amount of secretion and modify its character. In emphysema the perchloride is often valuable for its tonic power and its action on the capillaries, as well as for improving the impaired condition of the blood.

Cardiac Disease.—Dropsy.—Serous Effusion.—Cardiac pain and dyspnœa may often be relieved by iron preparations ; they probably act in an indirect manner, by improving the blood in the first instance—hence their advantage is seen most when

anæmia is present. Increased frequency of pulse is not, in itself, a contra-indication, but only when increase of tension is also detected. In mitral disease with dropsy and failing compensation, the acetate or perchloride is especially useful, if combined with diuretics: in some cases of fatty degeneration of the heart, in many of chronic valvular disease and in dilatation, these and other compounds are usefully combined with digitalis. It also acts powerfully in dropsy resulting from a state of anæmia or hydræmia of the system, and good effects may be obtained from 3 to 5 gr. of ferrum redactum taken at meal-times, or 15 to 30 min. of tincture of perchloride about half an hour after meals. Dr. Anstie has written strongly in favour of this in chronic pleuritic effusion, and my own experience quite corroborates his observations. Easton's, or a similar syrup of the phosphates of quinine, iron and strychnine, is useful in intermittent pulse, especially if anæmia be present; if there be much restlessness, bromide may be given in addition. Where the intermittency of the pulse is associated with general prostration and organic disease, the sulphate of iron is a good remedy.

Albuminuria.—The astringent preparations of iron are often useful in controlling the loss of albumin by the kidney; we must remember, however, that it is also possible to do harm by these remedies in renal diseases, and I have seen congestion increased by recourse to them during the acute stage (*cf.* Rotta, "Fer en Hydropisie," *Annuaire de Thérap.*, 1857). The best effect is certainly obtained later, when the urine is free from blood or inflammatory casts, when pain in the back and in the head, and the general febrile conditions are relieved, but the patient is pallid, weak and suffering from more or less anæmia and dropsy. Husemann praises it in "cachectic dropsy," and in that form which is connected with chronic nephritis and amyloid degeneration of the kidney; then the value of such preparations as the perchloride or acetate is often very marked, both as regards the general health and the discharge of albumin. Dr. Hassall attributes these good effects more to a reconstituent action on the blood than to any direct astringent power, because he could not detect either the metal, or the acid combined with it (hydrochloric), in his analysis of the urine (*Lancet*, ii., 1864). Parkes was one of the first to show, by quantitative analysis, the gradual lessening and final

cure of the discharge of albumin under the influence of perchloride: this was in a subacute case, when the early inflammation had subsided, and hospital nursing and the use of gallic acid had failed to relieve (*Med. Times*, ii., 1854). In all cases of this kind it is desirable to feel one's way with iron preparations, to begin at first with a small dose; and the recommendation of the late Dr. Basham to combine with it the acetate of ammonium is a good one. In albuminuria following scarlatina, especially when dropsy is present, tincture or infusion of digitalis alternately with tincture of perchloride of iron is a valuable prescription: it increases the flow of urine, at the same time that by its action on the blood and the capillaries it restrains the transudation of albumin.

In chronic forms of albuminuria the use of iron will require consideration: it is often useful, improving the condition of the blood more than any other remedy, but the cases in which it does harm are those with granular kidney, when the heart is large, the pulse hard and of high tension, and when there is much tendency to headache (*Dickinson, Lancet*, i., 1876). Hirtz has seen it hasten a fatal termination by uræmia, lessening the amount of urine, and increasing the production of urea (*Nouv. Dict.*, art. Fer), so that its effects should always be carefully watched: a very important point when ordering iron in any case of albuminuria is to obviate constipation.

Chyluria.—The perchloride of iron has sometimes proved useful in cases of this kind, even when they have lasted for several years (*Lancet*, ii., 1862).

Diabetes.—Carbonated iron waters are much esteemed as adjuvants in the management of diabetes; and a combination of bromide of potassium and citrate of iron has given good results, but I believe the iron only acts to a small extent, the bromides producing the best effects; with regulation of the diet and hygiene, I have frequently seen the general health improve and the amount of sugar grow less under these remedies.

Dyspepsia.—Although iron is contra-indicated in cases of acute and irritative dyspepsia and mal-assimilation, yet certain forms of "atonic dyspepsia" which are connected with debility and an impaired condition of the blood are well treated by it. There are the general symptoms of anæmia, and also a sense of weight and heaviness after food and impaired appetite, rather

than of acute pain, and suitable preparations are such as the citrate or ammonio-citrate combined with soda and calumba, or reduced iron with nux vomica: the headache which often accompanies this condition is also relieved by these medicines: when there is much general relaxation or gastric catarrh of chronic character the perchloride, preferably with quassia, is valuable. In the dyspepsia of chlorosis iron will often not agree if the tongue be furred, or the urine loaded: but if these conditions are present only in a minor degree, then the citrate may be used in effervescence with soda (Budd, On Dyspepsia). Dr. Milner Fothergill, in an article "When not to give Iron," insists on the importance of clean tongue and freedom from "biliousness," and quotes Sir J. Fayrer to the same effect (Pract., 1877): he remarks also that toleration of it diminishes with age. The hypodermic use of the drug may be indicated for dyspeptics.

Diarrhoea.—In simple cases occurring in weakly children, and continuing after preventable causes have been removed, vinum ferri is a mild but very useful astringent tonic, which is often sufficient both to stay the discharge, and to prevent its recurrence. In more serious cases of chronic mucous and dysenteric diarrhoea with slimy, bloody, offensive stools and tenesmus, whether met with in adults or in children, the best preparation is liquor ferri pernitratitis in doses of iron from 1 to 5 drops, as originally recommended by Neligan, and I have seen also much benefit from its use in the colliquative diarrhoea of phthisis. Graves specially advised it in the "nervous diarrhoea" which is liable to occur from emotional causes, and is more frequent in women: in cases with nausea and impaired appetite calumba may be well added to the iron. The citrate, of which 5 gr. are recommended for infants, or 30 gr. or Blaud's pills for adults, is also of benefit in removing the offensive odour of stools, whilst the perchloride with a little morphine is best for the diarrhoea (and cough) of phthisis (*ib.*, *ii.*, 1892).

Dysentery.—I cannot recommend iron preparations during the acute stage of dysentery, for I believe there are better remedies, but some practitioners have found them valuable. Bandon reports twelve cases suffering from tormina and very frequent sanguineous stools, which were treated by 12 to 30 min. doses of steel tincture internally, at the same time that about 12 min. with

water (and sometimes laudanum) were injected ; these cases were much relieved or cured within a week (Bull. de Thérap., t. 71). Blanvillon corroborated these results (Gaz. des Hôp., No. 130), and the same medication was largely used during the last German war (Lancet, ii., 1870) : as a general rule, it is better restricted to chronic stages of dysentery, and for the anæmia and debility attendant upon this condition it is of great value. Dr. Maclean's favourite remedy, especially in men returning from tropical regions, anæmic from loss of blood and the depraving influence of malaria, was the solution of the pernitrate of iron ; the citrate of iron and quinine may after a time be substituted.

Nervous Disorders.—Hypochondriasis, etc.—The nervous system naturally suffers when it does not receive a due supply of healthy blood : depression and a sense of oppression will be felt, whilst hysterical or hypochondriacal symptoms will be more or less pronounced : in such cases iron is often a valuable adjunct to other treatment and is especially suitable when combined with bromides. In the nervous symptoms which commonly occur in women at the climacteric period, including restlessness, anxiety, fluttering and sinking at the epigastrium, giddiness, clavus, and sometimes menorrhagia, the perchloride acts well.

Dipsomania.—Morbid craving for drink and alcoholic insomnia have been controlled by drachm doses of tincture of iron when many other remedies have failed (Med. Times, i., 1875). The sulphate has also given relief in such cases, especially when combined with aromatics.

Neuralgia.—Before the introduction of many modern remedies for neuralgia, large doses of the carbonate or oxide of iron were much relied upon, and when there is a chlorotic anæmic condition of the system they are of service. I should not consider iron a remedy for “idiopathic neuralgia,” but some observers have attributed to it almost a specific power, especially in neuralgiæ of the fifth nerve.

When *neuralgia of the stomach* occurs in anæmic or chlorotic patients, who complain of cramping pain and distension, accompanied with nausea and vomiting of mucus and water principally before breakfast, and of frequent acid and insipid eructations after meals, iron is useful especially in cases dependent on loss of blood or on protracted diarrhœa ; I have notes of many such cases cured by it.

Chorea.—When this disorder is associated with anæmia, iron is clearly indicated and may prove of service, as it did in the hands of Elliotson, who used large doses of the oxide. Sir T. Watson recommended the carbonate. Many cases occur about the time of commencing puberty, and others evince obscure rheumatic symptoms: in these also iron is useful, but it often acts better when taken in conjunction with arsenic.

Epilepsy.—Ferruginous medicines were at one time much esteemed in the treatment of epileps^y or of attacks resembling it, but as diagnosis became more exact, and more reliable remedies were discovered, iron passed out of use. Brown-Séquard taught that although it might improve the condition of the blood, it tended to aggravate the malady itself, and Dr. Hughlings Jackson, after much observation, expressed the same opinion. Sir Wm. Gowers, acknowledges that it is sometimes the case, but, on the other hand, he has found that iron has a true place in the therapeutics of epilepsy: he has observed benefit from it in cases that are on the border-land between epilepsy and hysteria, and in others when the attacks were limited to the night-time, and found the improvement fairly permanent: he suggests that it acts like silver or zinc as a nerve-tonic, rather than simply by hæmatinic properties (*Praet.*, 1877). Fabre has published a thesis showing the value of the medicine (*“Fer contre l'Epilepsie, Paris, 1853.”*). On the whole, we may conclude that iron has been unduly discredited in epileptic or epileptiform conditions, and certainly when a patient is anæmic it should be used, and generally with bromides.

Constitutional Syphilis.—This malady, like all others in which a poisonous material circulates in the blood, much impairs the condition of that fluid, rendering the corpuscles fewer, smaller and paler; in such cases iron becomes very serviceable, though it will not take the place of more special remedies for the principal disease. Ricord recommended the potassio-tartrate even in primary syphilis, and especially for phagedænic ulceration in debilitated subjects: the theory sustained in opposition to him by certain French writers, that iron aids the development of the malady, is not tenable. The iodide of iron I have found useful in the later stages of syphilis in cachectic subjects.

Tuberculosis.—Rachitis.—In the different forms of disease

included under these headings, and characterised by enlarged or suppurating glands, irritable mucous membranes, caries and swelling of the knee- and elbow-joints, emaciation, etc., iron, although much lauded by Hufeland, is not so serviceable when given alone as are certain alteratives—iodine, lime, etc.—but when combined with such remedies it is of great value for the cachexia, anæmia, and torpor of the blood-forming glands, which are its usual accompaniments. The perchloride, as already mentioned, is a good external application for suppurating glands. The *vinum ferri*, or an alkaline citrate with aromatics, is very useful in the *mucous diarrhœa* of rachitic children.

Worms.—The astringent tonic effect of perchloride on the gastro-intestinal mucous membrane renders it a good adjunct to purgative treatment for these parasites, and a useful prophylactic. When diluted it may be injected into the rectum for destroying ascarides: I generally use about 1 dr. of the liquor in 4 oz. of infusion of quassia: a stronger solution is liable to cause unnecessary pain.

PREPARATIONS AND DOSE.—Iron preparations, especially the liquid astringent forms, discolour the teeth and stain the tongue black—they should be taken through a glass tube: glycerin lessens the rough astringent taste, and a gargle of milk will relieve it (Guibout). A lotion of quadroxalate of potassium ($\frac{1}{2}$ dr. in $\frac{1}{2}$ pint of rose-water) will remove the black staining.

Mistura ferri aromatica (not off.) (made with iron wire, cinchona, calumba and aromatics): dose, 1 to 2 fl. oz. *Vinum ferri* (made with iron wire and sherry): dose, 1 to 4 fl. dr. and upwards. *Ferrum redactum* (containing 75 per cent. of iron): dose, 1 to 5 gr. for adults, $\frac{1}{4}$ to 1 gr. for children. *Trochisci ferri redacti*: each lozenge contains a grain of reduced iron. Reduced iron may be taken with advantage during a meal, the powder being mixed with the food. *Ferri carbonas saccharatus*: dose, 10 to 30 gr. or more. *Mistura ferri composita* (Griffith's mixture) (contains sulphate of iron, carbonate of potash, nutmeg, sugar and rose-water): dose, $\frac{1}{2}$ to 1 oz. *Pilula ferri* (Blaud's pill): dose, 1 to 3 pills. *Pilula aloes et ferri*: dose, 4-8 gr. (1 gr. of dried sulphate in each).

Syrupus ferri iodidi (contains iodine about 3 parts, iron 1 part, with sugar and water): dose, $\frac{1}{2}$ to 1 fl. dr.; each fluid drachm contains about 6 gr. (1 gr. in 11 min.) of iodide of iron. *Ferri sulphas*: dose, 1 to 5 gr. *Ferri sulphas exsiccatus*: dose, $\frac{1}{2}$ to 3 gr. or more (3 gr. with 2 of manna make a good pill). *Liquor ferri sulphatis*. (In Appendix.) *Ferri arsenas*: dose, $\frac{1}{16}$ gradually increased to $\frac{1}{4}$ gr. in pill. *Ferri phosphas*: dose, 5 to 10 gr. *Ferrum tartaratum*: dose, 5 to 10 gr. *Syrupus ferri phosphatis*: dose, $\frac{1}{2}$ to 1 dr. and

upwards (contains about 1 gr. of anhydrous phosphate of iron in each fluid drachm; is colourless when fresh). *Syrupus ferri phosphatis cum quininâ et strychninâ*: dose, $\frac{1}{2}$ to 1 dr. (contains in 1 dr. 1 gr. of anhydrous ferrous phosphate, $\frac{1}{3}$ gr. quinine sulphate, and $\frac{1}{32}$ gr. strychnine).

Liquor ferri perchloridi fortis. *Liquor ferri perchloridi* (contains 1 part of the last-mentioned to 3 of distilled water, sp. gr. .995): dose 5 to 15 min. or more. *Tinctura ferri perchloridi*¹ (contains 1 part of the stronger solution to 3 of rectified spirit, sp. gr. .995): dose 5 to 15 min. or more. *Liquor ferri pernitratidis*: dose, 5 to 15 min. *Liquor ferri persulphatis* (used to prepare the peroxide, etc.).

Ferri et ammoniî citras: dose, 5 to 10 gr. or more. *Vinum ferri citratis* (prepared with orange wine 1 gr. in each drachm): dose, 1 to 4 dr. *Ferri et quininæ citras*: dose, 5 to 10 gr. *Liquor ferri acetatis*: dose, 5 to 15 min.

The non-official preparations are very numerous, and include the following:—

Ferri sulphas granulata, *liquor ferri dialysatus*.

Ferri oxidum magneticum, *ferri peroxidum hydratum*, *ferri iodidum*.

Preparations of Tisy (French): these are all proto-salts and are sent out in capsules—as of Fer iodurê, etc.; analysis shows the quantity contained in each capsule to be very small, and not constant (Pract., vol. vii.).

Preparations of Creuse (American): these are double salts, such as a phosphate with ammonio-citrate—non-astringent; also a tasteless iodide and chloride (Pharm. Journ., May, 1873, and Feb., 1874).

Preparations of Robiquet (French): these are double salts, as a citro-ammoniacal phosphate; they are not definite in composition. *Preparation of Béchamp* (French): this is a peroxychloride, obtained by treating neutral perchloride with a varying quantity of peroxide; it is tasteless, not caustic or irritant, but hæmostatic (Med. Record, 1874). The preparations of Lebarquî, Bravais, Squire, Chateaud, Mangham and Wyeth, are different forms of oxide—"dialysed," "soluble," "colloid." *Van den Corput's preparation* is a double citrate of iron and magnesium (Belgian); that of *Saquet* is a pyrophosphate with soda, ammonia and malt extract; of Gude, a pepto-manganate; of Squire, a similar one with hæmoglobin. *Lightfoot's solution* is said to be a magnetic phosphate; the so-called "iron milk" is a white pyro-phosphate with aromatics.

Besides these, we have in more common use—*Bromide of iron*: dose, 1 to 5 gr. *Hypophosphite of iron syrup*: dose, 1 dr. (Pharm. Journ., v., vii.).

¹The tincture of perchloride often becomes turbid, which is due to its not containing sufficient chlorine, part of this gas having been driven off by the long process of evaporation which is required in order to drive off nitric acid; the quantity of acid ordered in B. P. is 25 per cent. over the quantity required by chemical calculation, and Schacht finds that by using less (20 per cent. less) he obtains a preparation having less hyponitrous ether, which keeps better (Pharm. Journ., Sept., 1872). The U.S. Pharmacopœia specially provides for the development of muriatic ether in the tincture.

Parrish's syrup of phosphates (compound), containing in each drachm 1 gr. phosphate of iron with soda and potash; *Beef and iron wine*; *Monse's solution* (liq. ferri subsulphatis); and many others. There are also granular effervescent forms in various combinations with arsenic, etc.

Organic compounds of iron are such as the *albuminate*, which has been made into a good lozenge with chocolate: dose, 10 gr.; the *succinate*: dose, 10 to 15 gr.; the *peptonate* (Robin); the malate, the glycerophosphate and ferratin.

Iron is also used in the manufacture of filters for water, and acts in the same way as carbon. One variety is that of the spongy iron filters; in another kind a mixture of carbon, iron and aluminium called Carferal is used.

Flitwick chalybeate spring, in Bedfordshire, is rich in iron and ought to be a good therapeutic agent; it has an acid reaction and a clear orange-red colour, and keeps bright even when exposed to the atmosphere for an indefinite period. Analysis proves that it contains a large amount of iron (21·3 gr. of ferric sulphate in the pint), with small amounts of alumina, lime and magnesia, combined with sulphuric acid as sulphates, and a large quantity of organic compounds derived from peat. It is said not to affect the teeth, nor to constipate (see also under chalybeate waters). Strong Levico water (South Tyrol) has ·66 per mille sulphate of iron, with ·00095 arsenious acid in each pint. Roncigno contains $\frac{1}{2}$ gr. of the latter with 20 gr. of the former.

HYDRARGYRUM—MERCURY—QUICK-SILVER, Hg = 200 (198·80).

Mercury is most frequently found in combination with sulphur as native sulphide or cinnabar, in mines in Almaden, Ydria, China, Peru, Japan and California. It is obtained from the ore by fusion with lime, which combines with the sulphur while the mercury distils over. It occurs also as a natural amalgam with silver—"argental mercury," and combined with chlorine in small grey crystals, known as "horn mercury"; also more rarely as an iodide, and sometimes in a pure state—"virgin mercury."

CHARACTERS AND TESTS.—Mercury is a silver-white metal with bluish lustre, fluid at ordinary temperatures, and susceptible of such

division that it may be squeezed in minute globules through chamois leather. When pure it has neither taste nor smell; it readily oxidises on exposure to the air, but does not tarnish; should tarnishing occur, it implies the presence of other metals, as lead, zinc, or bismuth; on agitation with alcohol, ether or turpentine, or trituration with sulphur or unctuous substances, it loses its fluid character. With other metals and even with hydrogen, it forms soft compounds termed *amalgams*, and a mere trace of it will leave a white stain on silver or gold. It has a sp. gr. of 13·59, which is exceeded only by that of gold and platinum, is slightly volatile at ordinary temperatures, boils at 662° F. (350° C.), and freezes at 39-40° F., becoming crystalline, tough, malleable and sonorous. Its specific heat is low, but it is a good conductor, and has a regular rate of expansion and contraction, hence it is well suited for thermometric and barometric purposes: from its power of combining readily with silver and gold, and yet afterwards quickly volatilising on being heated, it is valuable in the arts of gilding and silvering, and alloyed with tinfoil it forms the reflecting surface of mirrors.

Hydrochloric acid has no action on mercury, and hence the chlorides cannot be prepared in a direct manner. Sulphuric acid when boiling, and nitric acid whether cold or hot, form respectively salts of different degrees of saturation—*proto-* or *sub-salts* which are known as *mercurous*, and *per-salts* known as *mercuric*, which have much more active powers than the former.

The per-salts of mercury are many of them (as the perchloride and red iodide) soluble in ether, while the proto-salts are not, so that by this agent they may be separated from each other.

If any salt of mercury be heated in a test tube with sodic carbonate the pure metal will sublime, and it may be obtained from its various combinations by distillation. With sulphuretted hydrogen in excess, mercurial compounds give a black precipitate of sulphide, but the best general test is the deposition of metallic mercury upon bright copper. It may be applied by heating any mercurial salt with a strip of copper and a few drops of hydrochloric acid, and if the copper be afterwards heated, small globules of quicksilver may be obtained as a sublimate.

COMPOUNDS OF MERCURY.

HYDRARGYRI SUBCHLORIDUM—SUBCHLORIDE OF MERCURY OR MERCUROUS CHLORIDE—CALOMELAS—CALOMEL MERCURIUS DULCIS ($\text{Hg}_2\text{Cl}_2 = 471$).

CHARACTERS AND TESTS.—Calomel usually occurs as a heavy, dull white powder, nearly tasteless, which is rendered yellow by trituration or by gentle heat: if sublimed in a small chamber, fibrous crystalline lumps are produced. The specific gravity is 7·2. It is not acted upon by hot water, ether, alcohol or dilute acids, but potash or soda decomposes it with precipitation of the black oxide of mercury. Prussic acid also turns calomel black by causing the separation of metallic mercury. Pure calomel is entirely

volatilised by heat, and warm ether shaken with it should leave no residue on evaporation (showing the absence of corrosive sublimate).

*HYDRARGYRI PERCHLORIDUM—PERCHLORIDE OF
MERCURY—MERCURIC CHLORIDE—CORROSIVE SUBLIMATE*
($\text{HgCl}_2 = 271$).

CHARACTERS AND TESTS.—Corrosive sublimate occurs in white crystalline heavy masses, of sp. gr. 5.2; it is entirely volatilised by heat, is soluble in 16 parts of cold and 3 of boiling water, soluble also in alcohol, and still more so in ether. The strong mineral acids dissolve it without decomposition. A simple solution in water readily decomposes, calomel being precipitated, and if exposed to light and to contact with organic substances, metallic mercury separates. Ammonia gives a white precipitate of ammonio-chloride, potassic iodide produces the red iodide, potash a precipitate of the yellow oxide, and nitrate of silver a curdy white silver chloride. Albumin also combines directly with corrosive sublimate and precipitates its solutions.

*HYDRARGYRUM AMMONIATUM—AMMONIATED OR
AMMONIO-CHLORIDE OF MERCURY—WHITE PRECIPITATE*
($\text{NH}_2\text{HgCl} = 251$).

CHARACTERS AND TESTS.—This compound occurs as a heavy white powder, or in small cones marked by the linen filters: it has a metallic taste; no odour; is insoluble in cold water, alcohol and ether, soluble in warm acids; decomposed by caustic potash evolving ammonia, whilst yellow oxide of mercury is precipitated. Boiled with chloride of tin it gives a precipitate first grey and then black, from the presence first of subchloride and metallic mercury, and next of the metal wholly; this has been called the *magpie* test. Chlorine and bromine both act violently on white precipitate, forming mercuric chloride or bromide, the action in many cases being attended with explosion. With iodine, an explosion almost invariably takes place after a few minutes, iodide of nitrogen being formed.

*HYDRARGYRI IODIDUM VIRIDE—GREEN OR SUB-
IODIDE OF MERCURY (not off.)*
($\text{Hg}_2\text{I}_2 = 654$).

CHARACTERS AND TESTS.—The pure mercurous iodide is a yellow powder, but according to the mode of preparation or degree of exposure to light, becomes greenish and olive-coloured or even black; it is insoluble in water or ether; entirely volatilises when rapidly heated, but if warmed slowly in a test tube yields a yellow sublimate (pure mercurous iodide), metallic mercury being left: the yellow sublimate turns red on friction.

*HYDRARGYRI IODIDUM RUBRUM—RED IODIDE OR BIN-
IODIDE OF MERCURY—MERCURIC IODIDE*

($\text{HgI}_2 = 454$).

CHARACTERS AND TESTS.—A crystalline red powder, which becomes yellow when gently heated and again red upon friction or after cooling: this change in colour is due to a change in crystalline form, the yellow crystals being rhomboidal,—the red, octahedral prisms. The salt is insoluble in water, soluble in ether and solutions of iodide of potassium. The presence of iodine may be verified by starch producing a blue colour in a solution which has been digested with soda and acidified with nitric acid.

HYDRARGYRI OLEAS—MERCURIC OLEATE.

CHARACTERS.—It is a light-brown unctuous oleo-palmitate of mercury. Heated with a piece of copper foil, the latter becomes coated with a film of metallic mercury.

*HYDRARGYRI OXIDUM FLAVUM—
YELLOW OXIDE OF MERCURY OR MERCURIC OXIDE*

($\text{HgO} = 216$).

CHARACTERS AND TESTS.—A smooth yellow heavy powder, becoming grey on exposure to light; it is insoluble in water, readily soluble in hydrochloric acid, entirely volatilised by heat, being resolved into oxygen and mercurial vapour. This oxide is an allotropic form of the red oxide; it is smoother and combines more readily with certain acids; it is better adapted for ointment used on delicate surfaces as the eyelids, and is preferred for the preparation of oleates.

*HYDRARGYRI OXIDUM RUBRUM—RED OXIDE OF
MERCURY OR MERCURIC OXIDE—RED PRECIPITATE*

($\text{HgO} = 216$).

CHARACTERS AND TESTS.—An orange-red crystalline powder almost insoluble in water, soluble in acids, the solution giving a yellow precipitate with caustic potash in excess, and a white one with ammonia; it is wholly volatilised by a heat below redness.

*LIQUOR HYDRARGYRI NITRATIS ACIDUS—ACID SOLUTION
OF NITRATE OF MERCURY—MERCURIC NITRATE OR
PERNITRATE ($\text{Hg}(\text{NO}_3)_2 = 324$).*

CHARACTERS AND TESTS.—A colourless strongly acid solution, from which excess of caustic potash precipitates the yellow oxide;

water also decomposes the solution, precipitating oxynitrates. The presence of nitric acid is shown by the darkening of crystals of ferrous sulphate introduced into it.

*HYDRARGYRI SULPHURATUM—
SULPHURET OR SULPHIDE OF MERCURY—CINNABAR*

($\text{HgS} = 232$) (*not off.*).

CHARACTERS AND TESTS.—It occurs in dark scarlet shining crystalline masses which, when powdered, are known as vermilion; it volatilises on heating; on reduction with potash, metallic mercury separates out.

ABSORPTION AND ELIMINATION.—*Metallic Mercury.*
—The question whether mercury can be absorbed in its *metallic* state, either by the skin or the digestive tract, has been the subject of much debate, and contradictory facts have been alleged concerning it. Claude Bernard filled the medullary cavity of a dog's femur with quicksilver, closed the perforation with wax and allowed the soft parts to heal; three months afterwards most of the metal had disappeared from the bone, and was found in small globules encysted on the surface of the lungs. In another dog the metal was injected into the jugular vein, and twenty-five days afterwards found "*divisé à l'infini*" in the cardiac tissue under the pericardium, so that it would not remain in the blood, though taken up by it. Oesterlen used mercurial frictions on cats, giving them also internally pills of blue ointment, and he reported the finding of mercurial globules not only in the skin, but in most of the organs. Overbeck confirmed these results on rabbits, and Blomberg detected mercurial globules in cats to which he had given pills of citrine ointment (Treatise on Absorption of Mercury, Helsingfors, 1868). The latter observer used mercurial friction on the arm of a dead body, and found globules in the corium and mucous layers, but not deeper.

Such observations would seem conclusive but that Bärensprung, Rindfleisch, and others found it impossible to verify them: they made the frictions and gave the pills, but they could not find the metal in the blood, nor yet in the corium. Autenrieth could find no amalgam on plates of gold introduced into the subcutaneous tissue under the place of friction; and Gubler and Neumann, whilst they recognised the metal in the sweat-glands

and hair-follicles, could trace it no farther. More recent observations are those of Fleischer, who concludes from numerous experiments that "frictions with mercurial ointment cause the penetration of metallic particles into the superficial layers of the epidermis, but not deeper": and a consideration of the whole evidence warrants this negative conclusion, that although *metallic* mercury, when administered by the mouth in substance, or actually placed within the tissues, may circulate and be deposited, it does not seem to be absorbed in the ordinary sense, and when applied by friction it usually does not pass either into the deeper tissues or into the blood.

The physiological effects of mercurial frictions must be connected, therefore, with its absorption in some other form: either mercurial vapour is inhaled during the process, or some compound of mercury enters through the skin. As to the former point, we know that sometimes salivation has occurred in a wife, six hours after a friction made by the husband upon himself only, both living in rather a small room (Samelsohn, quoted by Hallopeau); and additional evidence in favour of such an effect is furnished by the delicate observations of Merget. He demonstrated that mercury volatilises at all temperatures, and by means of iridium-paper (which shows a dark stain on contact with the vapour), he proved its presence on the hands or other parts of the body of persons who had spent only a few hours in a workshop where it had been used (*Comptes Rendus*, Dec., 1871). That the mercurial vapour is not absorbed by the lungs alone is evident from a carefully devised experiment by Fleischer (Erlangen); he caused frictions to be made upon an arm whilst the patient—with face covered by a mask—breathed only external air; the limb was then carefully wrapped in wool and oiled silk for sixty hours, and during that time the presence of mercury (in very small quantity) was verified in the urine. Pinner rubbed blue ointment into the skin of a rabbit—15 gr. thrice in four days—and covered up the anointed part, so that no mercury could volatilise, but if absorbed at all, must be so through the skin; the animal died in thirty-two days. Twenty-four hours after the first inunction and up till death, mercury was detected in the fæces and urine, and hence he concludes that absorption through the skin must occur (*Therap. Monatshefte*, 1889).

We may state then that mercurial *vapour* is absorbed, not only by the lungs but also by the skin, and indeed the results of ordinary fumigations—when the head is external to the apparatus—would be sufficient to prove this. It is probable that some may be absorbed as *oxide* in combination with fatty or other acids contained in the secretions of the sebaceous and sweat-glands. Bärensprung and others have proved the presence of such oxide in “blue” ointment; Nevins calculated it at 1 part in 100, and Voit, analysing portions of skin which had been rubbed with it, found the oxide constantly present. A soluble double salt may be formed with the chlorides of the perspiration (Müller); and if mercurial oxides be given internally, Voit argues that the chlorides of the blood can change suboxide into calomel and peroxide into perchloride, which salts then combine with sodium chloride and albumin. Further researches on this point are those of Nega, who concludes (from fifty-five cases) that an ointment made with oxide is not more readily absorbed than one made with finely divided metal, and that the oleate is no better absorbed than grey ointment (French Ph.) or mercurial soap, but is less irritant (Rev. Gén., tom. 28, 1886).

Metallic mercury, given by the mouth, usually passes off unchanged by the bowel; in the rare cases where it has given rise to constitutional effects, a portion has probably been oxidised or changed into sublimate. In the very finely divided form, when the metal is “extinguished” by continued friction with chalk (grey powder), or with confection of roses (blue pill), Rabuteau thinks it may be directly absorbed from the intestine, but no doubt some oxidation occurs during trituration, and the oxide would be soluble more readily in the acid of the gastric juice: mercury in a volatile form would also be disengaged from such compounds as readily within the body as without, at the same temperature. Mercurial ointment or pill, introduced as a suppository into the rectum, produces physiological effects perhaps more quickly than by the stomach. In the various trades which require the handling of quicksilver—such as barometer and mirror-making, electrical meter-making, gilding, and skin-dressing, and, again, in miners at Almaden and elsewhere—the physiological effects produced are mainly traceable to inhalation of the vapour.

Calomel.—Calomel being insoluble in ordinary liquids like metallic mercury, there has been still more speculation as to how it could reach the current of the circulation.

According to the classic theory of Mialhe, it becomes, like other mercurial compounds, changed more or less into the soluble *perchloride* by the action of the gastric fluids, and is absorbed only to the extent of such change. Mialhe argued from the results obtained by heating together calomel and ammonium chloride in a test tube, but Buchheim and others failed to verify any formation of perchloride in such a mixture at the *temperature of the body*. Rutherford, experimenting more recently, digested 5 gr. of pure calomel in distilled water, with .02 per cent. of free hydrochloric acid—the same proportion as in gastric juice—at 100° F. for seventeen hours, and obtained $\frac{1}{3\frac{1}{2}}$ gr. of perchloride, but it is unlikely that even so much as this would be formed in the stomach; and the action of calomel so far differs from that of corrosive sublimate as to render it, clinically speaking, improbable that it *only* depends upon some formation of the latter. Observations of Fleischer confirm the view that calomel changes into perchloride under the action of chlorides, as also does the oxide of mercury (Rev. Gén., tom. 28, 1886).

Various observers have directed attention to the possibility of calomel being rendered soluble in other combinations, *e.g.*, with albumin (Buchheim), or as a double salt formed with chlorides of the blood (Graham). Headland pointed out that *bile* exerts some solvent power on calomel (Lancet, i., 1858) and Gubler asserts that an excess of various organic materials—*albumin*, *mucus*, *epithelium*—acts similarly; some limit, however, must be placed to this observation, for the excess of mucin in the stomach of a dog entirely prevented the absorption of calomel that had been injected into the stomach (Rutherford, Exper., 38). An experiment of Tuson's is more to the point: he placed in one vessel calomel with dilute hydrochloric acid, and in another the same mixture with a proportion of *pepsin*: after digestion for an equal number of hours sulphuretted hydrogen was passed into the solutions and produced a black precipitate in that with pepsin, but none in the other, proving clearly the effect of the organic substance in promoting the solution of the calomel. Jeannel pointed out the importance of *fatty* matters for the solution of

calomel; in the presence of an alkaline carbonate it is readily decomposed with precipitation of black oxide; of this latter a *small* proportion is retained in solution by the water, but if a fatty oil be mixed with the alkaline solution, this proportion is very much increased: the same might readily occur in the intestine.

It is possible, as H. Wood remarks, that in consequence of the varying composition of the intestinal fluids and the complex chemical relations of calomel, its solution and ultimate absorption may be accomplished in several ways: when more chlorides are present some perchloride may be formed, and when sulphuretted hydrogen is in excess it may produce some amount of soluble sulphide: clinically its effects vary, but not in accordance with the dose given, for 1 gr. will sometimes act like 5 gr. and *vice versâ*.

Bellini indicated a difference in the mode of absorption of calomel according to the condition of the stomach: thus when taken fasting, only a small amount was at first dissolved, with formation of double chloride of mercury and sodium, and lactate of mercury; more was dissolved in the intestine under the influence of an alkaline carbonate, oxide of mercury being at first formed and then a double salt; in the large intestine a sulphide was formed (except in the case of infants). Introduced into the stomach during digestion, it was wholly or almost wholly decomposed under the action of albuminous substances, metallic mercury being formed and a soluble albuminate.

Corrosive Sublimate.—The absorption of corrosive sublimate may be realised without difficulty, because it is soluble in ordinary fluids: an albuminate of mercury may be formed in the stomach, but is probably not absorbed as such: the formation of a double salt with sodium is more likely, and the same occurs with iodides and bromides of mercury. Blarez has published numerous observations on these points with chlorides and iodides given by the stomach: he always found a certain amount of finely divided free mercury in the intestinal tract, and this was susceptible of some absorption, whilst part passed out by the *fæces*. Soluble mercurial salts were formed with albuminoids and peptones, of which some were simple and some compound,—the latter did not join with serum or hæmoglobin, but remained dissolved in the plasma, and

were carried to the different tissues producing their effects quickly : the former combined to form insoluble compounds and were deposited in blood-forming organs, to be gradually redissolved, entirely or in part according to circumstances, *e.g.*, the administration of iodides (Rev. Gén., tom. 23, Thèse, 1884).

Saline or albuminous solutions of perchloride and aqueous solutions of cyanide are readily absorbed from the cellular tissue. The chlorides and iodides may also be absorbed from blistered surfaces (*endermic method*), when probably double salts with albuminous and alkaline constituents of the plasma are formed. The tannate of mercury is said to be absorbed with special facility under the influence of the alkaline intestinal secretions, and with fewer drawbacks than other preparations ; it is found in the urine within twenty-four hours after administration (Pract., 1891, and Lancet, i., 1900).

Elimination.—Shuster made more than 100 examinations as to the elimination of mercury in syphilitic patients who were at the time under treatment by inunction, or had been so a varying time before. The metal was, in many but not in all cases, found in the urine during, and for three to four weeks after, the course of treatment. In the fæces, however, it was constantly found from a few days after commencing inunction up to about six months after ceasing ; he concludes that it may be desirable to resume the treatment at the end of that time (Record, 1884). Certain Russian observers have calculated the elimination of average doses of $\frac{1}{6}$ gr. of sublimate given by the skin or under the skin, and have, in most cases, found the drug in the urine five hours after administration ; the amount thus eliminated gradually increased whilst under treatment and became more if stomatitis occurred. Elimination apparently ceased by this channel two or three weeks after the drug was last given (Lancet, ii., 1886).

The question of its elimination by the *milk* is one of much importance, for large establishments have been formed in Paris for the treatment of syphilitic infants especially, through the milk of nurses or of goats that have taken mercury : such treatment is constantly adopted with good result, and there is abundant clinical evidence of its value. On the other hand Somnia analysed the milk of seven women treated by inunction or injection of

mercury without finding a trace (Amer. Journ. Med. Sci., i., 1900).

With regard to the time during which mercury remains in the system, it is ascertained that elimination of a single dose is rapid, and is apparently completed within twenty-four hours; for $\frac{1}{6}$ gr. of perchloride having been taken, the urine contained traces for that period, but not afterwards; and 0.075 gramme (over 1 gr.) having been injected under the skin of a rabbit, none could be discovered in any part of the body four days afterwards (Lancet, i., 1873). M. Byasson injected $\frac{1}{3}$ gr. of sublimate under his own skin, and found mercury in the urine two hours afterwards, and at the end of four hours in the saliva, but after twenty-four hours he detected no more. If treatment has been continued for some time, mercury may be found in the urine for several days afterwards; thus, in the urine of two patients who took $\frac{1}{6}$ gr. daily for ten or twelve days, the drug was found for four or five days after treatment had been omitted.

During a mercurial course the greater part of the drug is eliminated almost as soon as taken, but some remains in the tissues and passes out very gradually; and when the doses have been large and long-continued, some may be retained in the organism for months or even for years. It is, in fact, impossible to recognise exactly when its elimination is complete, though it is probably sooner than that of gold, lead, or silver (Husemann). Years after its prolonged administration, unusual perspirations may develop dark mercurial stains on the linen, or a white coating be given to a piece of copper on handling it. Salivation may reappear with apparently no cause but a chill; sometimes it has been traced to the use of sulphuretted mineral waters, and occurred in one patient ten years after taking the medicine (Hartung). I have myself seen five patients while under the influence of nitric acid suffer from salivation and other physiological symptoms of mercury, and none of these had taken that drug for over eighteen months previously. The metal has been found in the liver of a workwoman who had not for twelve months previously been exposed to mercurial vapours, and in the liver and kidneys of another who died of phthisis six months after leaving her work at a mirror factory (Kussmaul, Gorup Besanez, Wien. med. Woch., 1862).

Melsens pointed out (1844) that iodide of potassium favoured

the elimination of mercury as well as of lead, and in many cases elimination which had ceased has been renewed under the influence of the iodide; but Kussmaul found a quantity of mercury in the viscera of a patient who had taken none for four months, and who in the course of a month after ceasing it had taken 2 oz. of the iodide.

Riederer has made experiments to ascertain the *quantity* of mercury that may be found in different organs or secretions: of about 10 gr. of calomel given to a dog in thirty-one days he recovered four-fifths—the largest proportion from the fæces, the next from the urine, the liver, the thoracic viscera and brain, and the least from the muscles (quoted by Hallopeau). Other observers agree that on section of an animal subjected to the action of mercury, the largest amounts are found in the liver and kidneys (and not in consequence of their containing more blood than other viscera, for the blood contained a much less proportion of the drug): it must therefore be considered to have a special determination to the liver and kidneys, and it is eliminated mainly by the bile and the urine. During a continuous treatment by equal daily quantities of mercurial ointment (and also by injections) analysis of the urine showed that the amount eliminated gradually increased according to the length of time of the treatment, but became nearly constant after about a month. After treatment for several months, and then cessation of it, elimination continued for six to nine months—the daily amount by the kidneys being about $\frac{1}{16}$ gr., less than half this by the saliva, some by the bowel. Sweating by hot air baths was found to hasten elimination more than potassium iodide. A practical conclusion from these researches is that it is well to stop the drug when the amount in the urine has reached its normal maximum (Abst. Pract., 1888).

PHYSIOLOGICAL ACTION.—*External.*—Metallic mercury produces upon the skin no other local effect than a sense of coldness. Mercurial ointment applied by friction is usually well borne, but sometimes excites a red or vesicular eruption (mercurial eczema); ointment of the red oxide is painful to sensitive parts, and that of the red iodide may irritate very severely, even to vesication,—if not perfectly fresh an additional source of irritation is found in rancid lard: good calomel ointment is rather soothing than otherwise. Cases illustrative of how acute local dermatitis

may result from the use of white precipitate ointment are on record (B. M. J., i., 1884; ii., 1883).

Corrosive sublimate is one of the most powerful antiseptics known, and of late years it has come markedly into use on this account; a strength of 1 in 10,000 is stated to be sufficient to kill bacteria. Solutions stronger than 2 gr. to the ounce irritate the skin. Cloquet the distinguished anatomist, suffered from severe local and general symptoms after handling some preparations steeped in a strong solution. A proportion of 10 gr. to the drachm of alcohol vesicates, and when applied to the scalp has caused death in a child (Lancet, ii., 1871). In two other children the use to the scalp of an ointment containing 120 gr. to the ounce of tallow also caused death (Dub. Journ., 1854). The solution of the metal in nitric acid (liquor hydrargyri nitratis acidus) is a powerful and painful caustic, and its application has sometimes, though not frequently, been followed by severe general symptoms: it combines with albumin and fibrin, producing a white eschar. A case of death from its injection into the vagina is on record (B. M. J., i., 1893).

On the mucous membrane of the intestinal tract mercurial compounds may exert a *local* action of the same nature as upon the skin, as seen especially in poisoning by the perchloride.

PHYSIOLOGICAL ACTION.—*Internal.*—In studying the action of this medicine, it is more than usually important to distinguish between the effects of *small* and of *large* doses. Modern observation shows us that the former are rather of tonic and constructive character, whilst older records have taught us only too well the destructive results of the “heroic” administration of the drug. I do not mean simply that one grain, *e.g.*, of calomel has a different effect from twenty: we must estimate the dose rather by what is absorbed of it, and by the results shown, especially by the state of the mouth and the secretions. Practically we can either give the medicine so as to cure without marked effect upon these, or so as to produce only moderate effects; and it is this “slight mercurialisation” which requires to be distinguished from the severe form which should be called rather mercurial poisoning, and is accompanied with stomatitis, salivation, diarrhœa, cachexia, etc. A similar difference of degree exists, of course, in the action of all powerful medicines, but it requires more attention in the

present instance, because our predecessors thought to give benefit only by what we consider a poisonous action of the drug, and it consequently fell into undeserved discredit. There is, further, a chronic form of mercurial poisoning which may still be met with in various trades, and this differs in some respects from any condition produced by modern medication.

Hæmatopoietic System.—Modern observations as to the action of mercury on the blood illustrate well its different effects, since they show that in quite small doses it increases the number of red corpuscles, and improves the condition of the circulating fluid. Grassi proved this by analyses, and Wilbouchewitz counted the average number contained in a cubic millimetre, and his patients (ten in number) then took either $\frac{2}{3}$ gr. of sublimate daily, or $\frac{1}{6}$ gr. of proto-iodide: during the first fortnight of treatment the increase of corpuscles amounted to nearly one million per cubic millimetre.

These patients were syphilitic, and probably the anæmia of their malady was benefited by the antidotal action of the mercury, for the remedy being continued beyond a certain time (and thus allowed to accumulate in the blood), the red corpuscles diminished in number, so that by the end of the second fortnight they numbered the same as before any treatment. Mercury being then omitted altogether, the corpuscles increased again within a week's time, *i.e.*, *too much* of the drug impaired the condition of the blood, but a *little* improved it. When it was omitted, and when, after a few days' time, only a small proportion remained in the blood, the original improvement was again observed: the white corpuscles varied in an inverse ratio (Archives de Physiologie, 1874). Keyes repeated these observations, and concluded that small doses of mercury increased the number of blood corpuscles *in all subjects*, whether syphilitic or not, and, further, that this increase was not temporary: he has never seen hypoglobulism—*i.e.*, a lessened average number of corpuscles—caused by small doses (Amer. Journ., Jan., 1876). Possibly the difference between these two observers may arise from difference in dosage, Wilbouchewitz giving the rather large quantity of $\frac{2}{3}$ gr. of sublimate daily. Schlesinger (Arch. f. Exper. Path. u. Pharm., xiii., 317) has found that in rabbits and more markedly in dogs the administration of small doses of mercury caused both an increase in the body weight and

in the number of red blood corpuscles, as compared with control animals to which mercury was not given. He attributes this good effect in health to the retardation of oxidation and the prevention of waste.

The so-called "Justus test" for syphilis is a sudden sharp fall of 10 to 20 per cent. in the hæmoglobin a few hours after inunction of mercury or its hypodermic use—not when given by the mouth; if a similar fall occurs in healthy subjects, the loss is quickly recovered from, but in the syphilised much more slowly (Virchow's Archiv, 1897). Tucker has, however, disproved the practical diagnostic value of this test for venereal ulceration, since he has shown it to occur in herpes, tuberculosis, etc. (Phil. Med. Journ., 1902).

No doubt mercury in any form, continued long enough and absorbed, will produce a *destructive* effect on the corpuscles, and a condition of spanæmia. Long ago, Bretonneau and Dumont reported that either there was no clot formed in the blood removed from mercurialised animals, or, if any, it was soft and diffuent. Headland's expression is that mercury "disintegrates and decomposes the blood," and Wright's analysis showed it to be more fluid and less coagulable than normal, its proteids, fibrin and red discs being diminished. Gubler has also corroborated this destructive effect, and yet Lemaire and Gelis found "mercurial treatment to increase the plasticity of blood." Autenrieth questions the analysis of Wright, and more lately Overbeck found in animals poisoned by mercury the venous blood dark and thick, the arterial blood clear and coagulating well, the fibrin being increased in amount: probably these results were connected with inflammatory reactions, but if verified they tell much against any available "aplastic power" of mercury in inflammation; still, the *ultimate* effect of the drug is destructive. Polotebnow, adding mercurial albuminate to the blood of dogs, found the corpuscles rapidly destroyed, with loss of their hæmoglobin (Schmidt's Jahrb., 1865). But when perchloride of mercury solution is added to blood outside the body, the corpuscles are fixed and retain their physical characters for an indefinite time. Wilbouchewitz, giving calomel to rabbits (and not in large doses), noted a rapid diminution of corpuscles. Recent researches on this subject are somewhat contradictory (B. M. J., ii., 1892, Epit.), but its

value must be acknowledged in certain cases of anæmia, and may be traced to stimulation of glandular structures, and relief of glandular engorgement (Pract., 1889). Kuperwasser, found that in health mercury reduces the number of the older leucocytes, and increases that of the young ones, while in the case of syphilitic patients the reverse is the case. The migration of white corpuscles is lessened by it. Trousseau found that leech-bites which had ceased bleeding, bled again in patients submitted to mercurial treatment, but beyond any single fact is the general experience that too much of the drug induces—after a period of malaise and restlessness—a chlorotic pallor of the skin, with signs of enfeebled circulation, distress of breathing, intermittent pulse and palpitation; such a condition, known formerly as mercurial spanæmia or “erethismus,” is difficult of cure; it may last long and end fatally.

Attention has been drawn to the value of calomel in reducing arterial tension, which effect Dr. Haig attributes to its lessening the amount of uric acid in the system (B. M. J., i., 1890), but his evidence is not conclusive. Fothergill includes mercury amongst his “cardiac depressants”; and G. Harley, having injected corrosive sublimate into the femoral vein of a dog, found that cardiac paralysis was produced before intestinal contractions ceased (Proc. Roy. Soc., 1864).

Nutrition.—Nutrition is so closely connected with hæmotosis that we shall be prepared for the modern observations that it also may be improved by *small* doses of mercury. Keyes found this to be the case—the weight of his subjects increased under their course, and the remedy acted “as a tonic.” Hufeland had previously made a similar observation, and Basset, Liégeois and others corroborate it; the last-named observer considers corrosive sublimate in minute doses “comme un réconstituant des plus puissants” (Annales de Dermatol., 1870), and M. Clerc reports the same experience (Gaz. de Paris, 1872): it has been verified also, independently of syphilis, on animals and especially rabbits.

On the important question of *urinary excretion* the principal evidence is negative. We need more research in this direction, but so far the evidence does not favour the theory of mercury (in small doses) curing disease by *increase* of tissue-change—that it lowers

the temperature in animals (except when "mercurial fever" occurs), and that it does the same in specific fevers (Wunderlich), I should take as evidence of its *lessening* change, rather than the contrary, as Husemann does. Mercury as a rule in ordinary doses (3 gr.) produces no effect on the temperature of the body; but 5 gr. doses of calomel have sometimes lowered the temperature; and exceptional cases have been recorded in which the administration of the drug produced pyrexia (Pract., ii., 1882). Altogether, at least in the doses under consideration, mercury merits the name of "moderator of nutrition," rather than of alterative (Rabuteau); and in this rôle we can see its analogy with small doses of arsenic, antimony, etc., under which, as is well recognised, weight may be gained and nutrition improved. Under full or poisonous doses, when the blood corpuscles are destroyed, the secretions rendered profuse, and digestion impossible, nutrition is, of course, profoundly impaired, and waste of tissue progresses most rapidly.

Digestive System.—Small (therapeutical) doses of any preparation are usually well borne by the stomach. Rabuteau cites cases where many hundred pilules of the proto-iodide have been taken in the course of one to three years without any gastric disturbance: yet we must allow for some idiosyncrasy in this respect, and practically we find that those who have resided long in the tropics, and fair, delicate women and chronic dyspeptics are very sensitive. It is not, however, possible to say beforehand what amount of mercury will produce the characteristic effects in any given case—a single friction or a few grains may produce in one patient what many weeks of treatment will not do in another.

Single doses of calomel—from 1 to 5, 10, or even more grains—produce thin and "bilious" stools without much griping. If the intestine of an animal be examined after such action, it will be found reddened, especially in the upper part, and its glands stimulated. Symptoms of constitutional action may be early detected in the mouth, such as a sense of heat, metallic taste, sticky coating of the tongue, increased flow of saliva and perhaps slight tenderness of the gums. On continuance of the medicine, these symptoms increase and diarrhœa occurs, with some nausea. The stools, at first semi-solid, become thin and sometimes papescent with mucus, sometimes yellow, or dark or grass-green

(the latter especially in children: they have been compared to "chopped spinach"): sometimes blood appears in the motions, and severe colic and tenesmus occur. The tongue is said to show a greenish coating with two longitudinal red stripes (Traube). In severe cases when the poisonous action of mercury has been induced, intense stomatitis appears, with swelling of the tongue and gums, a membranous deposit, fœtor and loosening of the teeth, with severe pain and difficulty in mastication. The salivary glands become enlarged and tender, and a vast amount of secretion pours from the mouth—10 lb. of saliva have been secreted in twenty-four hours: at first viscid as usual, it soon becomes thin and watery, containing albumin, mucin, and alkaline chlorides. (Children and the aged are seldom salivated—Graves suggests because their salivary glands are "inapt"—diarrhœa or prostration is with them the earliest symptom.) Salivation is partly dependent on local causes: it occurs more quickly when the mouth is unclean, and may be almost wholly prevented by great care with the teeth: dental caries will determine it; it is said to commence near the last molar on the side on which the patient mostly sleeps (Ricord): also the irritation of a wisdom tooth, or of a pipe, will influence it.

Such facts have led to the supposition that salivation is only *secondary* to buccal soreness, but this is incorrect: it may be induced by rubbing mercury over the parotid, and *before* any irritation is produced. Ricord detected the drug in saliva drawn from Steno's duct by a catheter, in animals when calomel had been injected beneath the skin; and salivation occurs, as we know, independently of irritation of the mouth from the action, *e.g.*, of gold, iodine, various acids, etc., as well as during pregnancy and certain diseases. The test of a mercurial salivation is detection of the metal in the secretion. Women seem to be more readily affected in this way than men, and the subjects of granular kidney, of tuberculosis and of scorbutus are peculiarly susceptible. It occurs more frequently under fractional non-purgative doses of calomel, or inunction of blue ointment, than from fumigation, suppositories, or injections: it is markedly less under the use of sublimate, iodide, or cyanide, than of insoluble preparations, either on account of the smaller dose of the former employed, or some peculiarity in their elimination. Ulceration or sloughing

of the gums, hæmorrhage, periostitis and prostration of even fatal character have occasionally followed a profuse salivation; and necrosis, scars and contractions have accompanied recovery.

We have seen that a local action, irritant in character, is exerted by most compounds of mercury on the alimentary tract; but H. Wood speaks of calomel as "free from all irritant properties," and Lente argues that large doses (one teaspoonful) act in a sedative manner (New York Journ., 1870)—this was the argument of Annesley, but it is not a safe one to act upon. The irritation excited by corrosive sublimate in toxic doses is, however, the most severe: there is an acrid taste and a sense of burning and constriction in the mouth and fauces, with whitening and shrivelling of the mucous membrane if the dose be concentrated; vomiting and purging with tenesmus usually occur, with passage of blood, suppression of urine and general symptoms of gastro-enteritis: after death, signs of inflammation, contraction, or ulceration have been found, especially in the stomach and upper part of the intestine, and that this is not merely a local effect is proved by its occurrence when the drug has been administered by the skin. Profound depression is usually a symptom of sublimate poisoning, and is sometimes more marked than pain, vomiting, or purging; salivation is by no means constant in acute cases.

The iodides of mercury act much like corrosive sublimate, the red iodide being more actively irritant than the green one. The red oxide produces similar lesions of the intestinal canal; it is not given internally in medical practice, nor is the ammonio-chloride (white precipitate), but in a case when a large quantity of the latter compound caused death the stomach was found contracted, and its lining membrane ecchymosed (Guy's Reports, 1874). A single dose of 20 gr. dispensed by mistake for sal ammoniac caused severe vomiting, purging and salivation—some albuminuria and illness for six weeks (B. M. J., i., 1889). The liquor hydrargyri nitratis acidus has produced intensely severe effects on the intestinal tract, and irritant poisoning has followed the accidental use of the sulphides and the cyanide of mercury.

Glandular System, Liver, etc.—Most of the glandular organs are liable to become congested and stimulated under the influence of mercury. This has been noted not only of the

salivary glands as already described, but also of the pancreas and intestinal glands, the kidneys, the liver and the testis (C. H. Jones, Med.-Chir. Trans., vol. xxxv.). As illustrating the effect on the pancreas Dr. Copland recorded a case where, in addition to salivation, deep-seated epigastric pain set in, with nausea and diarrhœa of thin fluid resembling saliva; after death the gland was found large and congested. Radziejewski found, on analyses of the stools after giving calomel, a large proportion of leucin, tyrosin and indol (the result of the action of the pancreatic ferment), which he did not find after other purgatives (Reichert's Archiv, 1870). That calomel also stimulates the intestinal glands was demonstrated by Professor Rutherford; the lymphatic glands are simultaneously affected.

The mode of its action on the liver is still a subject of discussion, and the conclusions of some physiologists on this subject are opposed to those of many practical physicians. For a long time mercury was universally regarded as a typical "cholagogue," in the sense of its stimulating both the secretion and the excretion of bile, and hence was commonly employed both in cases of deficient secretion to stimulate, and in cases of excessive secretion to "carry off" the excess.

The early experiments of Murray (1841) were taken to corroborate the theory of "cholagogue" action; for after giving purgative doses of calomel to dogs, he found the discharge of bile increased, and the stools contained excess of mucus and of serous effusion. Buchheim also reported an increase in the amount of bile discharged by dogs with biliary fistulæ. Still more important evidence was furnished by the analyses of Michéa, which were made first upon the normal stools of six healthy subjects without detecting bile; then, with nearly like result, upon the green stools of persons suffering from diarrhœa; then upon the greenish motions which occurred in eight healthy persons after taking calomel, and in all of which bile was clearly detected; and, lastly, upon discharges produced by different saline and resinous purgatives and in which no bile was found (Lancet, i., 1849). Although these observations show an increased *discharge* of bile under calomel, it is clear that they do not necessarily prove an increased *secretion* by the liver-cells, and therefore experiments on animals as to this point were undertaken. Köl liker and

Müller, after giving calomel to dogs with biliary fistulæ and collecting the bile discharged, reported contradictory results—the secretion being in one instance increased, whilst in two others it was diminished (1855). Scott, experimenting with large doses of calomel on four dogs (also with fistulæ), recorded diminution of both the fluid and solid biliary constituents in all the animals (Beale's Archives, i., 1858). Mosler, with two dogs, obtained a similar result (Virchow's Archiv, xxxii.) ; and the late Dr. Hughes Bennett, reasoning from the experiments of the Edinburgh committee, announced as a positive fact that mercury really *lessened* the biliary secretion in man as well as in animals (1868). The experiments on which this physician founded his important conclusions require a brief consideration: they were made upon forty-one animals, and on account of difficulties in the operations, etc., results considered satisfactory were only obtained in nine instances—in four of these calomel was used; a permanent fistulous opening into the gall-bladder was very carefully effected, and about fourteen days afterwards the bile was collected on a sponge. The first dog, before taking any drug, secreted a daily average of 87 gr. of bile, which contained 5 gr. of solid constituents; after taking 4 to 12 gr. calomel daily, it secreted only a daily total average of 60 gr.; but it must be noted that the animal's condition was much impaired, it took little food, and soon afterwards died. Smaller doses ($\frac{1}{16}$ gr.) were given to the second dog; the general health became affected, and it soon died: the average bile-secretion was about the same, before and after giving the drug. The third dog received some blue pill in addition to the small doses of calomel, and the average amount of bile secreted was diminished one-half; the animal suffered much. The fourth dog got purgative doses, with an average diminution of bile whilst under their influence; on one day, however, when blue pill was given, the average was increased (B. M. J., i., 1869). Such results scarcely warranted Dr. Bennett's conclusions, which were indeed publicly controverted by Christison, Fraser, and other members of the same committee. Röhrig (of Kreuznach) reported that large doses of calomel slightly increased the biliary secretion (Stricker's Jahrb., 1873), but we may take the more recent experiments of Rutherford and Vignal as showing, so far as experimental research can show, that the drug does not really

do so. They proved “(1) that doses of 10 gr., 5 gr., or 2 gr., several times repeated, placed (without bile) in the duodenum of a fasting dog, produced a purgative effect varying with the dose, but so far from increasing the amount of bile secreted, usually diminished it; (2) that there is no difference in the result if the calomel be given in 1 gr. dose, several times repeated, mixed with bile and introduced into the duodenum” (B. M. J., ii., 1875-76; Pract., 1879). On the other hand, the same observers found that *corrosive sublimate* in doses of $\frac{1}{2}$ and $\frac{1}{16}$ gr. powerfully stimulated the secretion of bile, whilst it did not stimulate the intestinal glands (B. M. J., ii., 1877). (They further instituted experiments which showed that calomel does not become changed into *corrosive sublimate* to any appreciable amount under the influence of the organic secretions (v. p. 669).) Rutherford himself notes that the experiments referred to above do not prove anything as to the action of mercury on the *bile-expelling* apparatus, and we may grant that they are correct without any denial of the clinical fact that a purgative dose of calomel will increase the amount of bile discharged by the bowel; it may do this, not necessarily by a previous stimulation of the liver, but either by irritating to unusual contraction the gall-bladder and bile-ducts, or by lessening a congested condition of these parts, through the discharge induced from intestinal glands.

Sir Lauder Brunton has pointed out that the clinical fact of calomel relieving “bilious” conditions receives from the experiment of Schiff and Lusana an explanation not inconsistent with Rutherford’s conclusions (Pract., vol. xii.); these experiments go to prove that the liver not only *secretes* bile, but also *excretes* it, separating from the blood a part of that which normally circulates in it: for after effecting biliary fistulæ in animals, bile flowed at first freely—afterwards in much diminished amount, independently of any drugs. This diminution was accounted for by the passing away of bile so soon as formed, and the consequent impossibility of its being reabsorbed from the duodenum into the circulation to be again excreted, for if *fresh* bile were passed into the blood by intravenous or subcutaneous injection, then the amount of excreted bile was again increased. Schiff further showed not only that bile can thus circulate without giving rise to jaundice, but that it probably always does so, passing from the liver to the

duodenum, thence into the blood and so to the liver again, a portion only in a changed condition passing out by the fæces.

This tallies with the observation of Murchison, that "by increasing the elimination of bile and lessening the amount circulating in the portal blood, mercury is a true cholagogue, relieving the liver thus, more than by merely stimulating it to increased secretion" (Lancet, i., 1874). The green, liquid, spinach-like stools produced by calomel have been variously attributed to intestinal irritation, to altered hæmatin (Golding Bird, 1845), and to subsulphate of mercury (Thudichum); it is possible that they may contain sometimes mercurial compounds, but they certainly often contain bile,—Hoppe-Seyler showed this, and according to Simon's analysis of the fifth stool passed after a large dose of calomel, it was fluid, green, without fæcal odour, of acid reaction, and contained mucus and epithelial cells, fat, cholesterin, bilin and bile-pigments,—no mercury whatever (Animal Chemistry, vol. ii.). Wasilieff asserts, as a result of experiments on animals, that the special action of calomel is to prevent certain processes of retrogressive metamorphosis and putrefaction in the alimentary canal; also that it prevents normal change in the colouring matter of the bile, which remains therefore, giving to the fæces the characteristic colour referred to. It prevents, too, changes in the pancreatic secretion, so that no indol is formed in the intestine whilst under the influence of a few grain doses of calomel (Zeitschr. für physiol. Chemie, 1882).

Reproductive System.—Women affected with mercurialism are liable to abort, yet it is also true that syphilitic women should be treated with medicinal doses, for thus given, mercury may save them from abortion. The influence on menstruation is not constant; generally this will be diminished, but sometimes much increased.

Lusana found that mercurialism in fowls prevented the laying of eggs, and Gaspard, that the vapour of quicksilver prevented eggs from coming to maturity.

Urinary System.—Therapeutical doses exert a stimulating effect on the kidneys, and we have seen that the drug is largely eliminated by those organs. Overbeck, indeed, found leucin and evidence of disintegrated albumin in the urine of animals (Husemann); but E. R. Harvey, experimenting on dogs, found the

quantity of urine unaffected, the phosphates always diminished, the urea not increased beyond a normal variation (Brit. For. Rev., 1862). Von Böck could find no definite change in the excretion of nitrogen or uric acid (1869), and more recently Conty, after observation on twelve syphilitics taking therapeutic doses of proto-iodide, could verify no definite alteration. Some careful experiments of Dr. Noel Paton on dogs seem conclusive as to the real increase in water, urea and uric acid excreted under moderate doses of perchloride and iodide. Von Böck showed a similar result in man, but his patient was syphilitic (B. M. J., i., 1886). It has been plausibly said that the increase of urinary water—diuresis—is dependent on the increased amount of urea formed under mercurial liver action (Pract., ii., 1886). Fractional doses ($\frac{1}{6}$ gr.) of calomel at intervals of three to four hours have been found markedly diuretic, but more so in disease than in health (v. p. 719).

During pronounced mercurialism, albuminuria may occur with or without hæmaturia (Pavy, Overbeck, Kussmaul). After death congestion and fatty degeneration of the kidneys have been found (Balogh and others); and Ollivier has pointed out the analogy between such conditions and those produced by lead. The albuminuria does not necessarily imply altered renal structure, it may be dependent only upon general dyscrasia and loading of the blood with organic débris, but in severe or prolonged cases steatosis is very probable. Bouchard has recorded two important illustrations; in one case of acute mercurialism, five days after salivation had commenced suppression of urine occurred, and on the ninth day the patient died comatose, and a very large amount of urea was found in the blood. We have not details of the second case, but in both, the Malpighian bodies were found to contain mineral matter, proved to be carbonate of lime (Hallopeau). This condition is very interesting when compared with Salkowski's results in rabbits; he injected fractional doses of sublimate, of iodide, and of calomel, and after death found constantly lime and soda deposits in the Malpighian bodies; the urine became pale and contained sugar, whilst the bones became decalcified. The latter observation has since been denied (Klemperer). Others also report congestion, hæmorrhage, cloudy swelling and deposits of chalk in the kidneys of rabbits—less deposit and more fatty de-

generation in those of dogs (Lancet, ii., 1890). Under some conditions, however, it is said to produce subacute inflammation and cirrhosis of the kidney, like lead. Cornil found calcareous deposits, and Kletzinski reported glycosuria.

Nervous System.—From the medicinal use of mercury we seldom see definite effects on the nervous system, beyond a temporary malaise, chilliness, depression, or hyper-sensitiveness; the severe symptoms of neuralgia, tremor, convulsion, or paralysis are met with only in persons who have been for a prolonged period or in great degree exposed to its action, such as those who work with it, and indeed suffer from a “chronic mercurial poisoning.” A grain of calomel or blue pill has been taken every night for more than forty years without other than good effects apparently, for one cannot argue much from fatty degeneration at the age of seventy-four (Med. Times, ii., 1867). On the other hand, tremor has developed in one night under the influence of strong mercurial fumes (Christison), but, as a rule, the slow and continued absorption by the skin and the lungs of metallic quicksilver or its vapour is the cause of symptoms such as those we are now considering. Ainstie pointed out that sensory nerves were sometimes affected by it, “a selective affinity” being shown for the fifth, whence an attack of severe and persistent facial neuralgia; but severe pain may also affect the head generally, or all the limbs (Lancet, ii., 1872), or the spine; the pains are usually made worse by warmth; tingling or other alterations of sensibility may be experienced; there may be partial anæsthesia or analgesia, which either varies as in hysterical subjects, or may be permanent; abnormal sensations of cold are also described. Tremor is the most constant symptom of chronic mercurialism: all the workmen in mercurial mines suffer from it, and sometimes it is the only symptom apparent, there being neither salivation nor erethism: it commences usually in the lips and the tongue, and soon affects the upper extremities; it is most marked, like the tremor of disseminated sclerosis, under the influence of voluntary movements, or of fatigue; it may exist in all degrees up to severe convulsive movement affecting the whole body (called “calambres” at Almaden): slight cases of tremor are curable in a few weeks; more serious ones last for months or years, and yet the subjects continue to walk and to work. The tremors cease during sleep,

and also, it is said, during intoxication ; this is an interesting fact, as also is the transmission of the malady by inheritance, so that children are born in the state of tremor.

Chronic mercurial poisoning sometimes produces a paralysis which resembles that due to lead and is characterised by dropped wrist, but it may be more general ; occasionally, as from lead, the laryngeal muscles are implicated, or hemiplegic weakness occurs. The paralysed muscles may show some wasting, but their electrical excitability is preserved. The sphincters are not affected.

It remains to note the *mental* condition in chronic mercurialism : emotional sensibility is generally heightened, the patient is timid and easily excited, intelligence is weakened, and a delirious condition may occur in paroxysms ; sleeplessness is marked. Convulsions resembling both the major and minor forms of epilepsy may be induced from mercury, as in lead poisoning.

With regard to the *pathology* of the nervous symptoms described, Anstie suggested that the cortical grey matter was mainly affected. Ross in his able paper seems to think that an effect on the connective tissue of the nerves would explain them (Pract., 1870). Mercury has been found by analysis in the brain, but we can scarcely consider its effects to be directly and locally poisonous to the nerve-cells : we may gain some light from the changes discovered in cases of alcoholic or saturnine saturation of the nervous centres, and those we find to be mainly chronic inflammation and fatty degeneration (Lancereaux, Vulpian). Dr. Popow has found that in animals, mostly dogs, mercury produces hyperæmia of the meninges and of the cord, followed by hæmorrhages and inflammatory exudation, similar to those produced by arsenic and lead. He found but few peripheral changes, and considers it proved that the nervous symptoms in mercurial poisoning are of central origin (Virchow's Archiv, vol. xciii.). Examination of the nerves in animals after poisoning by mercury shows, it is said, no affection of the axis cylinders, but degenerative changes in their medullary sheaths (Letulle, Arch. de Phys., 1889).

Cutaneous System.—We have spoken of the local irritation that may be excited by mercurial frictions. There may be merely erythema with much itching, or an eczematous (vesicular) rash, or even erysipelas and gangrene (Stillé). The internal use of mercury may also, exceptionally, give rise to eruptions, of which

Bazin has distinguished three forms, "hydrargyria mitis, febrilis, and maligna," showing either a simple efflorescence about the thighs, scrotum, abdomen and axillæ, or a more intense form with vesicles, or one still more severe with œdema and purpuric rash. The general symptoms in such cases may be serious: desquamation occurs in the milder forms about the eighth or tenth day; malignant forms (which I have never seen) may give rise to adenitis, abscess, or ulceration. Occasionally, owing to idiosyncrasy, a scarlatinoid rash may be excited by a single dose, as by $\frac{3}{4}$ gr. of proto-iodide in a case recorded by M. Fournier: one application of acid nitrate produced the same effect, as also did a few Dupuytren's pills ($\frac{1}{8}$ gr. sublimate). If cachectic ulceration be present, the action of mercury is likely to increase it, especially in the mouth: such ulcers are more irregular and less indurated than those of syphilis.

In exceptional cases the secretion of sweat has been increased, becoming of a clammy character and fœtid odour: a general brown colour of the skin or the occurrence of rupia and ecthyma has been sometimes noted, but it is not true that eruptions really equivalent to syphilitic eruptions are produced by mercury.

The hair and nails are said to have fallen off under its use. The teeth are said to show the effect of the drug, especially when it is administered in infancy, by a deficiency in the enamel, most marked in the first molars (Hutchinson, *Med. Times*, ii., 1876; Laycock, i., 1862); but I believe such deficiency may occur from rickets independently of mercury.

With regard to the tissues of the *eye*, we have evidence that iritis and retinitis may be produced by the continued employment of mercury, but a more usual condition is conjunctivitis, which occurs with the ordinary symptoms, such as suffused redness and injection, smarting, burning and some excoriation and purulent secretion.

Osseous System.—A form of periostitis occurs sometimes during a course of mercury, and it has been a question whether this is due to the remedy, or to the malady (syphilis) for which it is commonly prescribed. Pereira thinks the latter supposition correct, but Graves states that he has seen periostitis occur in patients mercurialised for some other illness who had never contracted syphilis, and to this I can add my own testimony,

having witnessed such an occurrence several times. The tibia, the bones of the forearm, the clavicle, sternum and frontal bones are those more commonly affected, and the pains, intermittent at first, are increased by warmth, or by changes of temperature, though sometimes relieved by a low temperature. The articular ends of the bones are liable to be affected, and even caries may be produced.

Idiosyncrasy.—Women are as a rule more susceptible to the general action of mercury than men, while children are less so. There is also marked difference in its effect on different individuals, among men, women and children. Subjects of Bright's disease are especially prone to serious symptoms of poisoning from even small doses of the drug.

SYNERGISTS.—Agents such as alkalies, which render the blood and secretions more fluid, favour a similar action of mercury. Oxygen, dilute acids and alkaline chlorides favour the transformation and absorption of metallic mercury, and hence assist its action. Bellini, however, concluded that these agents *lessened* the effect of mercurial chlorides and iodides by preventing the action of carbonated alkalies upon those salts in the intestine, and impairing the formation of double salts: *magnesia* he found distinctly adjuvant, it giving rise to a double chloride with mercury. Sodium carbonate has been found to increase its purgative effect (Hunt, Brit. For. Rev., 1852), and rhubarb, colocynth, jalap, or other purgatives are used to aid its action on the liver or intestine.

The cholagogue properties of calomel are naturally much increased by combination with a little perchloride, and also it is said by the simultaneous use of alkaline salicylates—there should be several hours' interval between the giving of these drugs.

Alkaline iodides markedly increase the constitutional action of mercury. A skin rubbed with *blue ointment*, and then after an interval and after cleansing rubbed with *iodine ointment*, becomes much inflamed, evidently from a chemical combination (biniodide of mercury). Similarly intense conjunctivitis may be caused by the application of calomel to the eyes of patients who have been taking iodide of potassium. Milk, bromides, sulphites and prussic acid are also said to increase the effect of mercurial compounds

(Bellini), and the good effects of mercurial treatment in syphilis are specially aided by the concurrent use of the sulphurous waters of Aix-la-Chapelle (B. M. J., i., 1874).

ANTAGONISTS AND INCOMPATIBLES.—Sulphur, especially in the form of sulphuretted hydrogen, antagonises the *physiological* action of mercurial compounds, whatever their therapeutical relations may be (see above). Chlorate of potassium controls, to some extent, its salivating powers; a mouth-wash containing boracic acid is useful for tender gums resulting from mercury; astringents such as alum and tannin lessen discharges, and tonics and stimulants oppose mercurial cachexia.

Treatment of Mercurial Poisoning (Acute).—By an emetic dose of ipecacuanha, if necessary, the poison should be as far as possible removed, and then albuminous demulcent drinks freely administered. The white and yolk of raw eggs with milk are very suitable, or gluten may be prepared by washing flour in a muslin bag under a stream of water, or the flour itself may be given in a paste (Tanner); the white of one egg is calculated to form an insoluble compound with 25 centigrammes (about $3\frac{1}{2}$ gr.) of the sublimate (Peschier). Opium may be required for the pain and purging, and gargles of alum and borax for the corrosion produced on the mucous membrane of the mouth and fauces. For salivation sulphur has been commended, and to promote elimination when the acute symptoms have subsided the iodide of potassium is to be advised. The symptoms of poisoning by corrosive sublimate are sometimes insidious, and after evacuating the stomach a principal indication is to sustain the strength, and stimulants are necessary. In a man under Dr. Mackey's observation, who had taken sublimate with suicidal intent and in large quantity, there were at first no symptoms, so that doubt was thrown on the history given with him when brought to the hospital. The stomach-pump was used, and for some days afterwards he complained of nothing but slight abdominal pain and weakness. Milk and beef-tea were given—perhaps not in sufficient quantity—but stimulants were not ordered: he died in about a week, apparently more from asthenia than from irritant poisoning, but an inflammatory condition of the large intestine was found. *In the subacute form* which follows the poisoning of mercurial trades there is apt to be much vertebral and abdominal pain,

accompanied with visible intestinal spasm, flatulent distention and sometimes diarrhœa: anæmia and emaciation are very marked: I have found vapour and Turkish baths, with internally sulphur, charcoal, and occasional anodynes, the best treatment for the former symptoms.

THERAPEUTICAL ACTION.—*External.*—The power of corrosive sublimate to destroy bacteria has led to its general use as an antiseptic in surgical and gynecological practice. Over carbolic acid it has the advantage of being odourless, of not numbing the hands, and of being effective in much weaker solution, 1 in 10,000, though the strength usually ordered is 1 in 1,000. This is well prepared according to the formula of Lord Lister, by making first a glycerin solution containing 1 part of mercuric chloride in $1\frac{1}{2}$ (by weight), and then adding 1 fl. dr. of this to 4 pints of water (B. M. J., i. 1884): soloids and tabloids are also convenient. In surgical operations the hands of the operator, the instruments, the skin of the affected part and all tissues exposed to the action of atmospheric germs are washed with such a solution—just as with carbolic preparations. As a general antiseptic the drug is reckoned by Lord Lister as second only to the last named. There is a large amount of evidence in favour of sublimate dressings preventing suppuration and septicæmia, and promoting union by the first intention (Kümmel, De la Croix, Schede, Bergmann, Weir and others). Sublimate lotions are largely used also for wounds, sinuses, and inflammatory and septic conditions of the skin, mucous membranes, and internal viscera such as the bladder and uterus.

Post-partum use.—Kehrer advocated such injections for the vagina and uterus after delivery, especially when metritis occurred (Med. Press, i. 1884), and a number of cases having been thus treated with success, injections of sublimate became almost matters of routine in several lying-in hospitals. Still such applications are by no means free from risks of their own. One of the earliest illustrations was reported by Stadfeldt in a healthy primipara irrigated with a solution of 1 in 1,500, and dying a few days afterwards with exhaustion, diarrhœa, sore mouth, pain, etc. The case was considered by some to be doubtful, but since that time further evidence of toxic enteritis has been accumulated (Fraenkel of Homburg, 1885). Lucien Butte noted diarrhœa a few hours after

dressing a wound,—at first watery, afterwards sanguineous and with pain.

Amongst a number of cases, salivation was rare, but albuminuria and headache occurred, and sometimes death followed from exhaustion; the principal lesions were found in the digestive tract and kidneys. A fatal case of Keller's is also reported, and a case of Murray's with severe diarrhœa,—and there are observations on animals to the same effect (Royer Charrière, B. M. J., ii., 1886). The cases of Richet and of Prévost show a large amount of success with some drawbacks, and one serious case from the surgical use of 1 in 1,000 solution. Müllen reports a death after sublimate dressing of an operation for cancer uteri (Record, 1886). Szaléo reports serious results short of death (Record, 1886), and Braun states as to vaginal injections that absorption is rapid, especially if the exit of fluid be delayed, and that mercury is soon found in the fæces: an injection should be used only for one minute, and followed at once by one of clean water (B. M. J., i., 1887). He thinks that a strength of 4 in 1,000 may be thus used in septic endometritis, but not when there is an open wound. Toxic symptoms followed a rectal injection of 1 pint of a 1 in 2,000 solution, though previously used per vaginam without any ill result. At the Obstetrical Society Dr. Dakin reported two serious cases, one fatal, but the general opinion was favourable—with the qualification that sublimate should be reserved for occasional use, and a less dangerous drug, *e.g.*, carbolic acid or permanganate be employed for ordinary daily injection (Lancet, ii., 1886). Dr. Playfair has formulated excellent detailed directions for the use of such solutions by the nurse (B. M. J., ii., 1887). Good authorities hold that not even a dilution of 1 in 5,000 is safe for an *intra-uterine* injection (Internat. Journ., 1889). Dr. C. R. Marshall has again drawn attention to the abuse of such injections, and their causing of pain, diarrhœa, albuminuria and collapse,—also headache, insomnia and delirium. The time of onset of such symptoms is variable—it is sometimes a few hours, occasionally days, and a fatal issue may follow seven or ten days later. Many foreign references are given (B. M. J., ii., 1902). On the other hand, Dr. C. Godson gives remarkable testimony to the value of sublimate injections—1 in 2,000—after delivery (Lancet, i., 1897). With the routine use of these,

not one septic case occurred in five years at the London Lying-in Hospital.

The perchloride has been used successfully in the disinfection of rooms, in much the same manner as sulphur,—50 to 60 gr. being placed on a shovel over a firepan in a room with doors and windows closed.

The biniodide has been much commended by some observers as even a more effective and convenient antiseptic: Miguel states that a strength of 1 in 40,000 is fatal to micro-organisms, and a vaginal injection of 1 in 4,400 is reported as safe and satisfactory (Internat. Journ., i., 1886, and B. M. J., i., 1887). Cheifetz supports the favourable account as regards surgical practice in sixty cases, including ovariectomy, lithotomy, herniotomy, resection of joint, and removal of the breast, all dressed with solution of biniodide. L. Napier recommends soloids of the biniodide, and Boxall testifies to the value of the salt for post-partum injections (Lancet, i., 1897). This also—used as a continuous bath to the open wound—was serviceable in a case of tetanus (Lancet, 1896),—but a strength of 1 in 500 caused salivation, and in another case pain and vesication (*ibid.*, ii., 1901); no doubt 1 in 800 is safer.

Phtheiriasis.—When pediculi infest the head or the clothing, ointments containing the red oxide or the ammonio-chloride will often suffice to cure, and have the advantage of being free from unpleasant colour or odour; mercurial fumigations may sometimes be required for the body. For the pediculus pubis blue ointment is commonly prescribed, but it is not a pleasant application and I have seen it produce much irritation. As in all cases when the hair is affected, destruction of the eggs or “nits,” which are closely attached to the hair, is important for cure, and for this purpose weak lotions of sublimate are good (2 to 3 gr. to 1 pint water), or strong lotions of vinegar or 1 in 40 carbolic, followed by the use of a dusting powder or ointment containing calomel or white precipitate, or oleate of mercury 6 dr. with ether 2 dr. M. Vigier recommends that a mixture of perchloride of mercury and glycerin (1½ dr. of perchloride in 8 oz.) should be employed as a parasiticide in these cases, the admixture with glycerin hindering absorption through the skin, and so preventing the general effect of mercury from taking place (Gaz.

Hebd. de Méd., 1882). I think sublimate *soap* 5 or 10 per cent. better and safer, but the full strength often irritates.

Tinea Tonsurans.—Pityriasis.—Favus.—The parasitic growths of these maladies may be destroyed by lotions containing 1 or 2 gr. of corrosive sublimate in the ounce, which should be applied once or twice daily after cleansing: ointments containing the same, or the ammonio-chloride, are also useful. Their curative effect, like that of all similar remedies, is often somewhat slow in ringworm of the scalp and especially in favus, but in ordinary ringworm of the body, and in pityriasis versicolor, a few applications will suffice for cure.

Dr. Alder-Smith has recommended the oleates of mercury as having more penetrating power, and records their curing chronic and obstinate cases not amenable to lotions and blisters: for children under eight he uses a strength of 5 per cent., and for others who can bear it, 10 per cent., mixed with acetic ether 1 part to 7; after cutting the hair close, thorough washing and drying, this is rubbed into the whole scalp regularly night and morning, a cap or turban being worn to keep any of the preparation off the face: it is important that the head should not be washed more often than once a fortnight.

Mercurial remedies should not be used too concentrated, or over too large a surface, for fear of producing severe constitutional effects; and it is well to remember that blistering increases the absorptive power of the skin (N. Y. Med. Journ., 1858). Under the heading of "absorption" have been mentioned cases in which death followed inunction of the scalp for ringworm, and one in which a single painting with a vesicating solution of sublimate (gr. x. ad ʒi.) caused salivation and death from mercurial poisoning (B. M. J., 1871). I have myself seen a case in which death resulted from the local use of a strong sublimate ointment, and more than one case with serious symptoms.

Eczema.—Herpes.—In the acute inflammatory stages of eczema mercurials are usually unsuitable as being irritant, but Dr. Spender speaks highly of the use of lotio hydrarg. nigra in eczema rubrum, applied fresh three times in twenty-four hours, without oiled silk (B. M. J., i., 1878). Salivation from the local use of such a lotion has, however, occurred (B. M. J., ii., 1891). In subacute and chronic stages with thickening

from infiltration of the cellular tissue, moderate crusting, scaling and dryness of the skin, mercurial ointments are very serviceable; that of the red oxide often irritates even at this stage, and that of the ammonio-chloride, diluted 1 in 4 or 8, is more generally suitable; Niemeyer specially commends it for chronic eczematous patches on the face. When there is more than average secretion or irritation better results are obtained by a combination with equal parts of lead or of zinc ointment, and a formula much used for eczema capitis at the Skin Hospital is the following: R. Plumbi acet., gr. x; Zinci oxidi, Hydrarg. subchlor., ung. hydrarg. nitrat., āā gr. xx; olei palmæ purif., ʒss; adipis recentis, ʒss, misce: such ointments are useful in the chronic general eczema of childhood especially.

For eczema mammæ, which is often very obstinate, Hebra uses sublimate lotions (1 in 120), but they require great care if any lactation is continued. For eczema of the genitals, Devergie recommended a very much weaker solution of the same; Guéneau de Mussey prefers calomel (15 gr. to $\frac{1}{2}$ oz. of lard). For eczema about the hands, and especially for "cracks" about the fingers and nails, an oleate of 5 per cent. strength is said to be very efficacious (Pract., vol. x.), and calomel ointment of the strength of ʒi to ʒi is serviceable for small patches of eczema, on the hands or elsewhere. I have found an ointment of hydrarg. ammoniatum, gr. x to ʒi, with some tar very useful for the same, and for eczema capitis et aurium after thorough removal of the crusts, and for most cases of chronic eczema. In sycosis, parasitic or not, mercurial ointments combined with sulphur often give good results. In herpes preputialis calomel is a useful dusting powder.

Impetigo Contagiosa.—The ointment of the "white precipitate" diluted to an equal amount acts almost as a specific in this affection. As in eczema, the crusts must first be removed thoroughly; this may be painlessly done by softening them with carbolised olive oil. In obstinate *pemphigus* frictions with the oleate of mercury—5 per cent. and upwards—may be useful (B. M. J., i., 1887).

Erythema.—**Ephelides (Freckles).**—Many cosmetic waters owe their efficacy to a minute proportion of sublimate or to an albuminate of mercury. M. Hardy's formula for the treatment of freckles contains lead acetate and zinc sulphate, of each 40 gr.,

sublimate 8 gr., with alcohol 2 oz., and distilled water 4 oz.; it acts by slightly irritating the epidermis, so that this exfoliates quickly. For a more decided effect Hebra uses a stronger solution (about 4 gr. of sublimate to 1 oz.), applying it for four hours till the skin grows red, or even is blistered, and then under soothing applications it peels off, leaving a new surface. For ordinary erythema of the face, a lotion containing 1 to 2 gr. in 4 oz. of almond mixture, with bismuth or zinc oxide, and spirits of wine, is very useful (though ichthyol is now often preferred).

Acne.—The last formula is suitable for many cases of acne when sulphur would not be well borne; but the pustules of this disorder may often be aborted with still more satisfactory results by means of the acid nitrate of mercury. The apex of the pustule should be lightly touched with this, on a glass brush or a match point, and the drop of liquid should be soon removed by blotting-paper or sponge; some temporary irritation may be expected, and strong carbolic paint has almost superseded this, as being less liable to scar.

Psoriasis.—The application just described (of acid nitrate) has been recommended for chronic patches of psoriasis, and especially for such as occur along the forehead at the roots of the hair, but it should be used with great caution. The ointments of white and of red precipitate have a certain value for psoriasis of the face, or scalp, or hands, because they have no unpleasant colour or smell, but they are seldom so efficacious as tarry or chrysophanic preparations. The iodides, with iodide of potassium, are also recommended (Rochard, Lailler). Mapother recommends not only ammoniated mercurial ointment locally, but the iodide or blue pill internally (B. M. J., i., 1891); Shoemaker uses injections of perchloride, and Brault of the yellow oxide, 5 cgm. injected six times in three months (quoted by Brooke).

M. Gubler has specially drawn attention to the cure sometimes obtained by general mercurial treatment in very chronic inflammations of the skin, such as psoriasis and eczema.

The carbolate of mercury is useful in macular and tubercular syphilides and in syphilitic psoriasis of the palms and soles of the feet, also in syphilitic rash and specific affections of the mucous membranes, and in papular and pustular eruptions, in doses of

$\frac{1}{16}$ to $\frac{1}{4}$ gr. three or four times daily; it is also used hypodermically with success in the form of a mucilage containing 2 per cent. (Lancet, i., 1887).

Leprosy.—Two cases of this disease are said to have been relieved by the subcutaneous injection of a solution of perchloride of mercury; about $\frac{1}{2}$ gr. was injected weekly (Crocker, Lancet, xi., 1896).

Prurigo. — Chronic Lichen. — Pruritus.—In all itching papular eruptions, hot dilute solutions of the perchloride are likely to give relief. Trousseau recommends a strength of 12 gr. to the pint, and justly lays stress upon the importance of its being used hot.

In *prurigo* the ointment of ammoniated mercury, either alone or combined with hydrocyanic acid, or with lead compounds, often gives relief, and *calomel ointment* is a good remedy for pruritus ani, and for pruritus of the scalp connected with chronic eczema or pityriasis.

Erysipelas.—Eruption of Small-pox.—Evidence may be found both for and against the use of mercurial ointment (ung. hydrarg.) in these conditions. The application cannot be depended on for the arrest of erysipelas, but it has some power to relieve the burning pain, and to lessen the chances of pitting in small-pox; it certainly can prevent the maturation of a vaccine vesicle. Dr. Hughes Bennett thought highly of this treatment, and Mr. J. F. Marson says that a mercurial plaster in use at the Children's Hospital in Paris answers well: it is a modification of the *emplastrum Vigo c. mercurio*, and contains 25 parts of mercurial ointment with 10 of yellow wax and 6 of black pitch; it is most suitable for semi-confluent cases, where the patient can use a little care, for in severely confluent attacks the application would soon be rubbed off by the restless movements. There is also some risk of salivation, and other forms of ointment answer equally well, so that although I have tried mercurial preparations in such cases, I have latterly abandoned their use. A spray, however, containing 2 per cent. of perchloride with ether, is a more suitable application, and is said to lessen pustulation (Pract., 1890).

Inflamed Lymphatics.—Adenitis, etc.—When the parotid, the testis, or the mammary gland is inflamed, gentle frictions with

mercurial ointment or applications of it on lint are suitable: in chronic superficial glandular swellings resulting from inflammation, or especially from syphilis, and also to procure absorption of inflammatory products in an early stage before suppuration has occurred, the same treatment is useful. The 5 to 10 per cent. solution of the oleate painted on night and morning is excellent, and I have known it succeed quickly in some cases where ordinary blue ointment had failed.

For inflammatory and congestive conditions of the *uterus*, but more particularly of the *ovaries*, a combination of mercurial and belladonna ointments in equal parts applied externally is sometimes useful.

Serous Effusions.—Pleurisy.—Hydrocele.—I have not been able to satisfy myself of distinct benefit from mercurial frictions in pleuritic or pericardial effusions, though they have been considered useful by others: for hydrocele in children Kock uses an ointment of the cyanide (1 part in 4), rubbing a very small quantity into the scrotum daily for three to six weeks unless erythema supervene: in such cases I have sometimes successfully employed as a paint a 2 to 10 per cent. solution of the oleate. A case of hydrocele, *æt.* sixty-eight, got well after injection of 1½ oz. of liquor hydrargyri perchloridi ($\frac{1}{16}$ gr.): slight orchitis was caused (*Lancet*, ii., 1895). J. Miller has recorded seventeen cases treated and cured by similar injections (*ib.*, ii., 1897).

Goitre (Cysto-Adenoma of the Thyroid Gland).—In true goitre, as distinguished from fibroid or purely cystic enlargements, an ointment of the red iodide of mercury succeeds, according to the large Indian experience of Mr. Macnamara, better than any other remedy. The strength he recommends is 15 gr. to the ounce of cerate, more than this causing unnecessary pain and soreness. A thin coating of such an ointment should be smeared over the goitre, which should then be exposed to the full rays of the sun, or at least to bright light: artificial heat is not so effective (*Frodsham, Lancet*, i., 1860). Within half an hour smarting and burning are felt, and in another hour a blister forms, which is treated in the usual way. The good effects of the red iodide continue long after this blister has healed, the tumour decreasing day by day for several weeks. One application of the ointment

every two months is sufficient for the most extreme cases. Mr. Macnamara has seen tumours which extended from the chin to the breasts disappear after two or three applications; from ordinary blisters he has never seen benefit in such cases, and the expensive iodine ointment was found to act very slowly compared to the mercurial preparation: he has never seen salivation produced by the red iodide, though it is said to have occurred in some exceptional cases.

Splenic and Glandular Enlargements.—Mr. Macnamara has also found the ointment of red iodide of mercury useful in the treatment of “spleen,” meaning the chronic enlargement resulting from malaria (ague cake): he gives at the same time “ague powders” (quinine). At Netley this ointment formed part of the accepted treatment for such cases, phosphates of iron, quinine, and strychnine being given internally (Murchison, B. M. J., i., 1867). Dr. Andrew reports advantage from the same ointment at St. Bartholomew’s Hospital (Lancet, i., 1869). Of course, in the enlarged spleen consequent on mechanical impediments to the circulation and heart disease, or on blood poisoning as in typhoid, or on waxy or other structural degenerations, mercurial ointments are useless, and even in malarial enlargements harm may be done by them, because splenic disease seems to render the system peculiarly liable to salivation and other ill-effects of mercury. Sir Joseph Fayrer has observed serious results from its use in splenic cachexia, with tenderness of the organ and much debility (Med. Times, i., 1874).

The ointment is equally applicable in tuberculous enlargement of lymphatic glands.

Inflamed Joints.—In any persistent articular inflammations, whether traumatic, gouty or rheumatic, mercurial ointments or oleates are useful applied with friction two or three times daily. Mr. Scott (Bromley) earned a high reputation by his successful treatment of “white swelling,” chronic synovitis, etc., with a mixture of mercurial ointment, camphor, soap, and cerate, applied on strips of lint firmly covered with plaster strapping. Although this method is useful I commonly prefer gentle friction with an ointment of the ammonio-chloride, beginning with a strength of 1 part of the official ointment to 4 of simple cerate, and using afterwards 1 part in 8 two or three times daily. Under this simple

treatment, with rest, I have known good results occur which other remedies had failed to procure: thus in one case of chronic inflammation of the wrist-joint, where able surgical and hydropathic treatment had been fairly tried, this ointment relieved more than any other means, and in several cases of chronic disease of the knee-joint condemned to amputation, the limb has been saved (though with a stiffened joint) by this application.

Ulcerations.—Whitlow.—In chronic indolent or suppurating sores even when non-specific, the “black or yellow” lotions containing the respective oxides are very good applications, and the ointment of the red oxide is a valuable stimulant. Martin has strongly recommended blue ointment in *whitlow*, rubbing it in every hour in intervals of poulticing. I have also used this treatment with some advantage, but the frictions need not be so frequent. Chronic indolent ulcers of the leg, whether syphilitic or not, often heal quickly with small doses of mercury, and lotions or ointment of the same when applied to a similar condition hasten cicatrisation.

Syphilitic Ulcerations and Eruptions.—It is in these forms of disease that the efficacy of mercurial lotions and ointments is the most marked. For *condylomata*, calomel with astringents is a good dusting powder, but the acid nitrate lightly applied is still more effective: one application will sometimes destroy the growths when nitric acid alone and other caustics have failed (Pract., Aug., 1874). The injection of 15 min. of a 1 per cent. aqueous solution of formamide of mercury, at intervals of three to four days, is said to be very successful (Lancet, ii., 1890). Kopp and Shoemaker agree that this is very suitable for mild forms of syphilis, whether primary or secondary, but that it is not so good for severe cases or for tertiary forms as the perchloride or inunction. The acid nitrate is also the best agent to employ in the rare cases when it is desired to destroy a chancre by caustic in its early stages. As a dressing for hard chancre and for squamous and ulcerative forms of cutaneous syphilide the “emplastrum mercuriale” (Prussian form) is recommended by Dr. Liveing; it contains metallic mercury (3 oz.), turpentine (1½ oz.), and lead plaster (12 oz.).

For generalised syphilitic eruptions, especially those of papular or scaly character, baths of corrosive sublimate have been recom-

mended by Baumé, Trousseau and others; but their proportion of $\frac{1}{2}$ oz. to each bath I think too large: headache, drowsiness and sometimes colic and diarrhoea were produced, and the skin irritated by them. Baths containing only 10 to 15 gr. have been found very useful for syphilitic infants (*cf.* Pract., 1891).

Gonorrhœa, etc.—Weak injections of sublimate (1 gr. in 8 oz., 1 part in 20,000 and 30,000—Leistikow) have been found very effective in this disorder (Record, 1883-85); also the perchloride in vaseline in the same proportions, or cyanide—5 in 1,000 (Pract., ii., 1899).

In cystitis, with ammoniacal urine, the injection of weak solutions (1 in 10,000) of corrosive sublimate is of value: in every case the bladder should be afterwards thoroughly irrigated with warm, recently boiled, water to prevent the absorption of the salt.

Epithelioma.—Lupus.—A similar injection, $\frac{1}{4}$ gr. in a pint of water with glycerin, has given much relief in painful uterine epithelioma: it was used twice daily, and presumed to act by lessening infiltration, as well as by disinfection (B. M. J., i., 1885). Cases of epithelioma have been relieved by repeated painting with the acid nitrate of mercury, the morbid growth being destroyed in layers (Gay, B. M. J., i., 1862), and this mode of treatment is applicable with due care in instances where operation is not desirable; it has been used to the *cervix uteri*, but has sometimes caused salivation.

Extending patches of lupus are often controlled by the nitrate, but it is not so useful in the *erythematous* as in the *ulcerative* and *discharging* forms: its application is very painful and should not be repeated more than once or twice weekly, and should be followed by soothing remedies. This method of treatment is, however, specially applicable to small nodules remaining or recurring at the edges of a large patch after scraping, and may be carried out by means of a pointed splinter of wood, which should be well pressed into the growth. In chronic torpid ulcerative conditions, M. Lailier recommends an ointment containing the red iodide with iodide of potassium (about 7 gr. of each in 3 oz.), which is useful but irritant: it may be applied stronger to non-ulcerative forms. Cinnabar is combined with arsenic in "Cosme's paste," which is very useful for superficial lupus patches about the face: three applications are usually made, for twenty-

four hours each time (*v. p.* 501). Calomel dusted on after the application of creasote has been found effective in some cases (*Rev. Gén.*, 1885). Local injection of 5 to 6 min. of a 1 per cent. aqueous solution of perchloride sometimes gives good results, though there may be much reaction, with swelling and even abscess (*B. M. J.*, ii., 1892). The perchloride, together with zinc chloride, carbolic acid, iodol, and sedatives, forms the paste of M. Félix (Brussels) for destroying lupus, *nævi*, and malignant growths. Fournier has recorded a case of ulceration, tubercular—not syphilitic—which healed under hypodermic injections of calomel (*Lancet*, i., 1897).

Diseases of Mucous Membrane.—Syphilitic Throat, Tongue, etc.—In ulcerative conditions due to syphilis, gargles of “black-wash” or applications of calomel in substance are most useful: more active effects are, however, to be obtained from painting with dilute acid nitrate—1 part in 8 or in 16: 1 min. to 1 oz. of water is sufficient for a spray (*Lyster, Liverpool Hosp. Rep.*, 1870). A solution of the cyanide (5 or 10 gr. to 1 oz.) is also useful to paint on syphilitic sores in the mouth. Trousseau used mercurial cigarettes for these and for laryngeal affections. A gargle of bicyanide of mercury ($\frac{1}{2}$ gr. to 1 oz.) is most useful when blackwash and other preparations fail. For syphilitic and other ulcerations of the Schneiderian membrane, an ointment of the grey oxide is preferred ($\overline{3}$ ss ad $\overline{5}$ ss): a powder containing cyanide of mercury and camphor may be cautiously used.

In *Ozena* injections of black or yellow mercurial lotion are of some service, with powders for insufflation containing calomel, bismuth and white sugar: a spray 1 in 4,000 of biniodide was recommended by Dr. Illingworth.

For *Otorrhœa* the ointment of the red oxide is recommended, a little being placed in the external auditory meatus; it is said to be an efficient antiseptic, but when the discharge comes from diseased bone local antiseptics are probably useless.

In *Chronic Angina* good results have been obtained from the local use of the diluted acid nitrate of mercury (1 part to 6). It has relieved “nervous cough,” and also, it is said, spasmodic asthma (*Bull. de Thérap.*, xxiii., 1842); this action would be of reflex character. In *Diphtheria* solutions of perchloride (1 in 1,000) have been found valuable, applied locally. For *chronic*

Laryngitis and *Eustachian catarrh* Dr. Nevins has written in favour of mercurial vapour; it may be obtained from cigarettes made with blotting-paper soaked in a solution of the nitrate (Trousseau). A curious application of *metallic* mercury is for the removing of solid lead from the ear (Lancet, i., 1892).

In **Strumous** and **Catarrhal Ophthalmia** a lotion of corrosive sublimate is one of the best remedies, especially in conjunction with the internal use of the same preparation, or of calomel: 1 or 2 gr. of sublimate are to be dissolved in 6 oz. of water, and of this, 2 dr. with an equal part of hot water applied three times daily. Under this lotion the conjunctival redness is lessened, the corneal pustules and ulcerations of the lids heal, whilst the discharge, lachrymation, photophobia and irritability of the adjacent mucous membrane all diminish; in this affection is well seen the special power of mercury to check threatening supuration and to heal ulceration. Irrigations of sublimate, 1 in 2,000, are effective in contagious conjunctivitis (Record, 1885).

In **Blepharitis**, when the sebaceous glands near the ciliæ become inflamed or obstructed, causing redness, crusting and irritation, mercurial lotions or ointments applied at bedtime, after due cleansing, are very serviceable. Calomel ointment is the mildest, that of the red oxide the most energetic (B. Carter), but that of the freshly precipitated yellow oxide, introduced by Pagenstecher, is now the most generally used (Ophthalm. Rev., v., ii.). I have been well satisfied with the effect of white precipitate ointment diluted with three or four parts of lard, and Haltenhoff (Geneva) prefers this.

Hordeolum (or "stye") is often best treated by applications of the same three or four times daily.

Phlyctenular Ophthalmia and **Keratitis** of scrofulous character have been cured by insufflations of calomel. In opacities and nebulae of the cornea, thickening of the tissue is somewhat diminished by the use of a small fragment, about the size of a pin's head, of the ointment of red oxide every night for some months; this is placed under the lid, and then gently rubbed over the cornea by means of the finger outside the lid. Sometimes this application excites much irritation and even deposit of false membrane, which is presumed to be from formation of perchloride: mercurialised lanolin may be better (Pract., 1889).

THERAPEUTICAL ACTION.—*Internal.*—A *general* effect may be obtained as we have already seen, from *local* applications made in several ways—by inunction, by endermic painting or hypodermic, intramuscular, or intravenous injection, as well as by suppository or fumigation.

Inflammatory Diseases.—From the time that Robert Hamilton described his successful treatment of inflammation by calomel and opium (Duncan's Commentaries, 1764) down to perhaps thirty or forty years ago, mercury in some form was, in English practice at least, the almost universal remedy both for acute inflammations and for their results, such as effusions, adhesions and indurations. Trousseau described mercurials as "*les anti-phlogistiques les plus puissants*"—more active, perhaps, than blood-letting,—and Nothnagel remarks that at one time the name of any malady ending in "*itis*" seemed sufficient to indicate their use. Sir Thomas Watson, in the later editions of his classic Lectures, quotes his own earlier opinion that "mercury is a very powerful agent in controlling inflammation, especially when acute and 'adhesive' in character, also in preventing exudation," but owns that this can be said no longer—"it requires much qualification" (5th ed., 1871). This is perhaps the most important point in which modern experience and opinion would discredit the therapeutical power of mercury. It is not denied that full doses can act destructively on the blood and the tissues, though we have given some evidence against its aplastic energy, but modern clinical experience affirms that it has not *great*, but comparatively *little* power over *acute* inflammatory disorders, that these often run a natural course towards recovery independent of mercurial or other medicinal treatment, and that when it is pressed to a full effect convalescence is protracted by greater anæmia and debility. (The unquestionably good results recorded from the treatment of Hamilton, which led to its general adoption, have been plausibly attributed to the *opium* rather than to the *mercury*.) Sufficient account of the evils that followed was not made by our predecessors, who knowing too little of the natural history of disease attributed all bad sequelæ to *it* rather than to the medicines, and considered themselves successful if, when "the disease was subdued," life at least was saved.

We cannot, on the other hand, agree with the assertion that

mercury is never useful but always injurious in inflammation. There is evidence of its advantage in certain conditions, though this evidence is not so consistent or so general as of its value in syphilis. It will certainly remedy some of the *results* of inflammation, as chronic effusions in joints or pleuræ, and as Dr. Stephenson remarks when narrating such cases, no number of instances in which the medicine has been abused, or has even failed, can contradict the cases in which it has conferred evident benefit (Edin. Med. Journ., 1871). For my own part, I still hold it useful in many chronic inflammations whether syphilitic or not, affecting mucous membranes and parenchymatous tissues, and having a general tendency to suppuration and ulceration—but I am satisfied that it should never be pushed to salivation.

Meningitis and Cerebral Disorders.—The principal difficulty in judging of the effects of mercury in meningitis, and of the relative value of recorded cases, lies in the uncertainty of diagnosis. Cases of cerebral congestion, in children especially, present at first symptoms very similar to those of simple meningitis, such as pain in the head, vomiting, injection of the eyes, excitement followed by semi-coma, pyrexia, and even convulsions. Many years ago I usually treated such cases with minute doses of perchloride or iodide of mercury, and, as I thought, with moderately good results, but further experience has not satisfied me on this point. Many surgeons prescribe it in *traumatic* cases and believe it relieves the fulness of the cerebral vessels. When the malady follows on febrile or eruptive diseases, or spreads from caries—*e.g.*, in the ear-bones—mercury is not likely to relieve it, and in some other non-tuberculous cases I think aconite, belladonna and bromides are of more importance in the early stages, and nourishment and perhaps iodides in the later ones. In cases presumed to be tuberculous I use iodide of potassium, generally with cinchona. Sir William Gowers recommends the inunction of mercury as distinctly useful.

Chronic Hydrocephalus.—Of this disease, Gölis recorded a large number of cures under $\frac{1}{4}$ to $\frac{1}{2}$ gr. doses of calomel twice daily and mercurial inunctions of the scalp, but his results were not confirmed by other observers. Sir T. Watson refers to two remarkable cases cured by a mixture of metallic mercury 10 gr., fresh squill 5 gr., and manna, taken three times daily for three

weeks: it caused weakness, emaciation and diuresis, but not ptyalism. I have not myself seen any good result in this condition from mercury.

Pericarditis.—To treat this inflammation without mercury would formerly have been reckoned almost criminal, and men no less eminent than Graves and Stokes have left their emphatic testimony in its favour—the latter gave 20 gr. of calomel once or twice daily. Yet soon afterwards Markham and Walshe began to doubt its value, and Todd denied it wholly. Watson says: “I am obliged to recant my advice as to giving mercury in acute pericarditis” (Lectures, 1871), and Hayden is almost alone amongst modern writers in still recommending calomel and antimony (Diseases of Heart, 1876). Waters, Austin Flint, and Loomis have discarded mercurials, and Sibson in his able monograph does not even mention them (Reynolds’ System, vol. iv.). Sir A. Garrod states that full mercurial treatment of the joint-affection in rheumatism will not prevent pericarditis, and it would seem, therefore, scarcely likely to arrest it after its commencement: further, as it is almost always connected with, or dependent upon rheumatism, its treatment should naturally be conducted on the same principles, and as we do not now give mercury for the main disease, why should we do so for one of its local manifestations? I have carefully watched its effects several times, and although the bruit and other physical signs have varied during the attack, I have never been able to satisfy myself of a definite influence of the drug upon the malady; on the contrary, I have seen this prolonged to more than an ordinary duration whilst the gums have been sore. In subacute or chronic cases where effusion has occurred and is persistent, I have seen benefit from small doses of sublimate or grey powder and mercurial applications locally, but when the effusion is very large, the pulse feeble and cardiac paralysis threatening, any excess of mercury must be carefully avoided (Nothnagel).

High-Tensioned Pulse.—In cases of contracted kidney where there is high-tensioned pulse and consequent sleeplessness, venesection or a dose of calomel may relieve the condition. In many other cases of sleeplessness accompanied by a similar condition of the pulse, but without the underlying renal disorder,

blue pill may act as a soporific. Dr. Tyson refers to a similar effect in "bilious attacks" (B. M. J., i., 1891).

Endocarditis.—In rheumatic endocarditis, on account of the still more serious issues involved in exudation and adhesion, more advocates are to be found for the use of mercury in the hope, at least, of controlling such results. I myself treat this affection on the principle recommended in a previous paragraph, *viz.*, that treatment of the rheumatism, the cause of the cardiac mischief, with salicylates, iodides and alkalies is the most effective for its complications: this should in all cases be combined with rest, and in certain instances opium also may be indicated.

Pleuritis.—Fuller and Walshe may be named amongst modern advocates of mercurial treatment in pleurisy, but for the acute stage I cannot see its advantage, since aconite, salines, belladonna, or morphine, with suitable local applications, give usually all the good results that can be expected from medicines. When effusion has occurred, however, I believe that mercury may be of considerable service in stimulating the absorbents. I have also noted benefit from this medicine in pleuritis occurring in puerperal women; a similar observation is recorded by Nothnagel, and in a patient *æt.* forty, with extreme prostration and much effusion, not improving after paracentesis, much benefit followed mercurial inunction (M'Dougall, *Pract.*, i., 1884; *cf. ib.*, i., 1878). In no case should it be pushed to the production of salivation or anæmia.

Peritonitis.—Velpeau was the great advocate for a thorough mercurial treatment of this inflammation, and by enormous doses of calomel, used concurrently with inunctions, he expected so to alter the blood in a few hours as "to prevent its furnishing the elements of a severe inflammation." Trousseau adopted for some time a similar method, for which he substituted later that of Dr. Law, giving minute doses frequently. Without accepting Velpeau's theory, it may be said that mercurial treatment—or rather calomel with opium—has been less completely abandoned in this inflammation than in many others. Watson certainly says "he is doubtful if it has ever done good, whilst if it purge it must do harm," but I believe that small doses of calomel or of sublimate ($\frac{1}{100}$ to $\frac{1}{50}$ gr.) have conduced to the recovery of some of my cases of acute and "idiopathic" peritonitis. I have

generally given them every one to three hours alternately with aconite, and used opium as required for relief of pain. In localised forms of peritonitis, occurring, for instance, after perforation, or from perityphlitis, opium is the most important remedy and mercurials should never be given: operation has now always to be considered.

Pneumonia.—In the early stages of acute pneumonia formerly treated by calomel and antimony, I cannot recommend mercurials, but the time for using them with advantage is when secondary fever arises, and there is reason to fear purulent formation. So far as I can judge, they have seemed to exert some power in preventing this, for certain cases of the kind have improved on commencing the use of sublimate, and others have relapsed on its omission. In pleuro-pneumonia with copious effusion, the same remedy is still more clearly indicated, and in chronic interstitial pneumonia it sometimes has excellent effects. Sher advocates the treatment of croupous pneumonia by local applications of cold and by rubbing in grey ointment (2 dr. daily); this appears very effective and is said to shorten the duration of the disease considerably (Voënnö-Sanitarneö Delo, No. 26, 1885). Sometimes a syphilitic deposit occurring in the lung, rendering it partially solid and giving the physical signs of a pneumonia, seems to “melt away” under the moderate action of mercury: but careful diagnosis of such cases is required, for in tubercular deposit the drug is injurious.

Bronchitis.—In acute cases with much congestion of the mucous membrane and scanty expectoration, small doses of perchloride are often useful. In certain cases narrated by Thorowgood, blue pill with squill was given with apparent advantage, when there were “severe cough at night, pyrexia with loaded urine, dyspnœa, some lividity of lips, difficult scanty expectoration, with râles and perhaps impaired resonance” (Pract., i., 1878): this treatment is more suitable for robust adults than for the aged. In catarrhal bronchitis passing into pneumonia, frictions of the chest with oleate of mercury are said to be useful. A spray containing a solution of perchloride of mercury ($\frac{1}{8}$ gr. to 3 oz.) has been employed in order to relieve the fœtor in foetid bronchitis.

Coryza.—In ordinary coryza, especially when there is much

sneezing, I have often found small doses of grey powder cure more quickly than any other remedy. Catarrh affecting the Eustachian tube is also well treated in the same manner.

Whooping Cough.—Goldschmidt used a solution of the perchloride (1 in 10,000) applied locally to the throat in whooping cough. The throat was irrigated every two hours during the first day and subsequently every three hours.

Diphtheria.—**Croup (Laryngeal Diphtheria).**—Stillé, after giving many authorities in favour of the mercurial treatment of diphtheritic disease, says himself “that it appears urgent that the system should be brought under mercurial influence as speedily as possible,” and, following Albers, he recommends $\frac{1}{2}$ gr. of calomel every hour, and a scruple of mercurial ointment to be rubbed at intervals into the thighs. Trousseau, finding that the direct application of calomel to external diphtheritic surfaces modified favourably their condition, recommended its use by insufflation, or by allowing it to mingle slowly with the saliva; this has not, however, given much result. Bretonneau used mercurials freely, but his mortality was great and contributed to induce a general distrust of the treatment. West, however (ed. 1859), still considered calomel useful for “counteracting the tendency to formation of false membrane and preventing lung-inflammation.” I have been much disappointed with the action of calomel in these respects, but the red iodide and the cyanide of mercury, in doses of $\frac{1}{30}$ to $\frac{1}{50}$ gr. every two to four hours, have exerted a more favourable influence in some severe cases. It is very important to watch their action carefully and not to induce salivation, for according to general experience this promotes rather than checks the spread of exudation, and certainly, as a general rule, other remedies of a tonic or antiseptic character are to be preferred to mercurials.

The treatment by mercury has been again advocated of late years. Schutz recommends the cyanide, but most of his confrères object to such treatment for fear of collapse (Rec., 1884). Thallon, Lange, Linn and others, however, support it (Med. Times, 1884; N. Y. Journ., 1884). A series of sixty cases without one fatal issue under perchloride is given by Mr. Coward. Drachm doses of the liquor hydrarg. perchlor. were given every hour for several hours to both adults and children—less frequently after the first

few hours (B. M. J., i., 1891). Dr. Illingworth was an enthusiastic advocate of the biniodide, and my experience of many years back is in its favour. It remains to be seen how far the use of the diphtheria antitoxin will replace all other methods for the treatment of diphtheria, especially in regard to its efficacy in relieving the toxæmic state. Calomel vapour has been of service in croup (Lancet, i., 1889).

Tonsillitis.—In ordinary tonsillitis, and even in suppuration about the fauces, I have seen advantage from small doses of hydrarg. c. cretâ. In early stages of quinsy, in ulcerated sore throat and even in the "putrid" form (cynanche maligna), $\frac{1}{2}$ gr. given every two to four hours has induced rapid improvement; it does not exclude the use of aconite or belladonna if indicated by high temperature or much pain. In parotitis, also in glossitis, "cancrum oris," and cracks and ulcerations about the mouth and lips, the same treatment is effective. In a slowly resolving acute tonsillitis and in subacute cases, an insufflation of calomel is highly efficacious in accelerating recovery. For relaxed congested conditions of the faucial mucous membrane the value of dilute solutions of mercurial nitrate locally has been already indicated.

Scarlatina.—The small doses of hydrarg. c. cretâ just mentioned I have found equally useful in the severe specific sore throat of scarlatina, especially when the cervical glands and adjacent cellular tissue are inflamed and swollen, and when there is ulceration or even a tendency to gangrene.

The biniodide is advocated, as in diphtheria, according to the following form: Liq. hyd. perchlor. $\overline{5}$ i, potas. iod. $\overline{3}$ ss, syrup $\overline{5}$ viii— $\overline{3}$ ss every two or three hours. Some observers, however, have thought nephritis more frequent after it (B. M. J., i., 1889). It is also used as spray—1 part in 2,000: or the perchloride may be employed double that strength.

Morbili.—Half-grain or quarter-grain doses of grey powder given every four hours will also control the catarrhal symptoms of measles: when the conjunctivæ and mucous lining of the nose, mouth, and throat are inflamed, and even when ulceration is present, they render excellent service.

Variola.—When the eruption is passing into the pustular stage and secondary fever is setting in, I can recommend $\frac{1}{2}$ gr.

doses of hydrarg. c. cretâ every three to four hours for a few days. Unless the gums show signs of tenderness, this treatment tends to check and limit suppuration, and consequently to lessen in some degree the chances of pitting. The local use of mercurial ointment has been already mentioned.

Anthrax.—The remarkable observations of Dr. T. Cash showing that small doses of sublimate are prophylactic against anthrax in animals may here be referred to (B. M. J., i., 1886 and 1887). The bacilli exposed for ten minutes to solution of only 1 in 25,000 are rendered innocuous (Klein). A number of cases in men have been reported in which, after excision of the affected part, powdered sublimate— $\bar{z}i$ to $\bar{z}ij$ —has been sprinkled over the wound with excellent result,—a slough formed, and in a few days separated,—there were no toxic symptoms (Record, 1886). Remarkable improvement in Indian cases of anthrax is reported from dressing with a lotion of sublimate, 1 in 1,000, 2 dr. of the same being injected near the sore (B. M. J., ii., 1890).

The ung. hydrarg. nitratis has special repute for aborting boils (Edin. Med. Journ., 1888).

Enteric Fever.—We need not do more than refer to the older method of treating this fever by repeated purgative doses of calomel (*v. Stillé*), a method not now advocated, but several eminent physicians abroad—Traube, Wunderlich, Liebermeister and others—have recommended a “specific” treatment for the first nine days of this fever by calomel, giving 10 gr. in a single dose the first day, and 8 gr. (in divided doses) daily for three or four days afterwards; they claim for these doses an anti-pyretic effect, and a power of lessening both the duration and the mortality of the disease (Med. Times, ii., 1876). I have not had much experience of this treatment, nor, although foreign statistics show good results, has it made way in this country. An early moderate purgative dose is, however, often advisable, and Black has written to recommend one or two 5 gr. doses of calomel during the first week, as “antiseptic” (Lancet, i., 1875). Corrosive sublimate in minute quantities has also proved valuable in typhoid diarrhœa, this being in accord with my experience, and $\frac{1}{3}$ gr. of biniodide thrice daily is said to disinfect the stools (*ib.*, ii., 1891). Calomel is one ingredient in the “Woodbridge treatment”

(American) combined with podophyllin, guaiacol, menthol, thymol and eucalyptol.

Apart from the facts that the perchloride of mercury is so largely diluted by the contents of the alimentary tract, and that it combines with albuminous matters to form inert albuminates, thus decreasing its antiseptic action, it is a bad principle to administer large doses of drugs having a marked aperient action in diseases characterised by severe diarrhœa. If it is given, the proper time to administer it in the treatment of enteric fever is when diarrhœa sets in and ulceration is commencing. If given earlier than this I have found that the diarrhœa comes on sooner than usual, and that it is greatly aggravated by the continuance of the drug, especially when given in $\overline{3}$ ss to $\overline{3}$ i doses of the liquor every 4 to 6 hours. I have seen the perchloride given as an antiseptic in the early stage of enteric fever, and have never known it do good; on the contrary, not only does the diarrhœa set in earlier and with greater severity, but there is more liability to the occurrence of severe and repeated hæmorrhage from the intestine.

I have known the liquor given in half drachm or drachm doses three or four times daily, commencing on the ninth or tenth day, and persisted in during the whole course of the disease. The effect was distinctly to aggravate the symptoms and to induce a condition of alarming exhaustion, the victim dying emaciated and worn out by repeated hæmorrhage and literally wasted away by diarrhœa. The point to remember is that if half drachm to drachm doses of the liquor be given, so as to act as an antiseptic, it is injurious, not only by bringing on diarrhœa, but by increasing the condition of anæmia from its destructive action on the red blood corpuscles. When ulceration and excessive diarrhœa have set in and the remedy has not been previously used, the perchloride often acts beneficially, and it lessens the tympanites and the danger of perforation.

The proper dose is from 5 to 10 minims every four hours, and should not be exceeded. If the diarrhœa proves obstinate, grain doses of opium may be given from time to time.

Puerperal Fever.—Traube has also revived mercurial treatment in some cases of this disease—not for the general blood poisoning—but at the commencement, when phlegmonous inflam-

mation is spreading from the uterus and involving other parts, *e.g.*, the peritoneum or pleura. He considers that a rapid and energetic mercurialising by calomel and inunction gives the best results, that such cases bear large doses well, and that improvement generally coincides with the first signs of salivation. Spiegelberg especially observed the good influence of corrosive sublimate in similar conditions—he gave $\frac{1}{6}$ gr. at a time (Nothnagel). Concerning this treatment, I can only say that I have not had occasion to adopt it, aconite, opium, quinine, etc., seeming to be much more desirable remedies. Sublimate is, however, much used as an injection (*v. p.* 691). It is probable that before long the value of antistreptococcic serum will quite outweigh that of older remedies in puerperal conditions.

Erysipelas.—In many cases of phlegmonous erysipelas, especially when occurring in strumous subjects, I have found the internal administration of corrosive sublimate distinctly useful.

Syphilis.—In 1497 Gilinus first employed mercury in the treatment of syphilis, then epidemic, borrowing his practice from that of the Arabians in skin diseases, and using only external applications by friction, bath, or fumigation. Several serious accidents that occurred from the remedy as used by empirics contributed to discredit it, and in 1517 it was almost entirely superseded by guaiacum. Not long afterwards, however, the internal administration of corrosive sublimate, red precipitate and calomel became general, and by the time of Boerhaave was carried to such excess that mercurial treatment was not considered thorough and satisfactory till it secured the ejection of three or four pounds of saliva in twenty-four hours. Protest against such abuse was not wanting, and between mercurialists and anti-mercurialists sprung up a controversy which has lasted to our own time. In the early part of the last century a reaction of opinion against the extravagant use of the drug in syphilis became general—thanks mainly to Rose, Guthrie, Thomson and Abernethy—and it was proved that syphilis sometimes tends to spontaneous cure, and yields to non-mercurial treatment. Later on, the distinction was made out between the soft or non-infective and the hard infective sore, and professional opinion pronounced strongly in favour of mercury for the latter, whilst allowing it unnecessary in the former, and in gonorrhœa.

This was clearly evidenced in the report of the Admiralty Commission on the subject, which records the opinions of forty eminent practitioners (1864). Amongst others, Sir James Paget called mercury "a specific—if the patient could take it well; in favourable cases it would prevent secondary symptoms, and at least it would shorten their duration." Mr. Hutchinson speaks of it as a "true vital antidote and, if given early, as really stopping the development of symptoms, and absolutely curing the disease." Whilst agreeing with this conclusion, I do not discard wholly the use of mercury in soft chancre, for I find that small doses cause the sore to heal more quickly than any other medicine.

Constitutional syphilis is commonly divided into three stages, fairly well distinguished as primary, secondary and tertiary, and the best period for giving the remedy has been much discussed. Some have maintained that its early exhibition only *defers* the appearance of secondaries, and it is better for these to appear and then to give mercury till they disappear; but the best authorities favour early commencement. Sir Alfred Cooper has, however, objected to too early use, as liable to obscure the diagnosis (*Lancet*, i., 1892). Ricord gave mercury—generally the iodide—so soon as the hard chancre was distinctly diagnosed, and insisting on a year's continuance of treatment, was satisfied that he prevented secondary symptoms. Barallier supported the same conclusion after much experience amongst sailors. The majority of British surgeons follow this practice at present, and it seems to me the right one.

On the other hand, most are agreed that in tertiary stages of syphilis mercury is not a desirable remedy, and a reason for this is found in the different processes which occur at different periods of the malady. In the primary and secondary periods plastic lymph is being effused, but in later stages degeneration is going on; mercury causes absorption of the effused products, but its *further* action can only assist degeneration, induce cachexia and be thus injurious. As clinical evidence of this if any were needed, reference might be made to the cases recorded by Mr. Hutchinson, where phagedænic ulceration in delicate subjects distinctly increased under the influence of mercury (*Lond. Hosp. Rep.*, vol. ii.). Also, if any syphilitic sore be much inflamed, or if aggravated dyspepsia, anæmia, phthisis, or albuminuria be present, special treatment for these conditions must be instituted indepen-

dently of mercury. Pregnancy has been by some considered a bar to due mercurial treatment, but in my opinion the danger of miscarriage in the mother and of injury to the infant are greater from syphilis than from mercury.

In any case a *moderate* use of the drug must be the rule. It is true that Trousseau and Pidoux blame a relaxation of the old methods for what they consider the present gravity of the disorder, but the large majority of the best authorities, including Ricord, Sigmund and Hutchinson, deprecate full mercurialisation, and find the best effects from small doses continued for a long time. Hutchinson uses grey powder in 1 gr. doses from three to six times a day, with enough opium to prevent diarrhœa, and seldom for a shorter time than six months: attention to the teeth is necessary, and soups, green vegetables, fruit and malt liquor should be avoided. Sir Alfred Cooper recommends the tannate of mercury, 1 to 2 gr. in pill thrice daily: it is quickly absorbed and eliminated, and is little likely to cause stomatitis (Lancet, i., 1900). Sigmund stated that of nearly 9,000 patients treated in the Vienna Hospital, 8,500 showed no sign of salivation, but were cured as permanently as those salivated. Slight tenderness of the gums may be safely and properly produced as evidence of systemic influence, and a method sometimes successful is to give fractional doses ($\frac{1}{12}$ gr.) of calomel every hour; given in this manner, 3 gr. may suffice for the purpose (Law). In hereditary syphilis mercury is still to be preferred; but in all forms of *tertiary* syphilis, in rupia, and deep ulcerations, especially of the mucous membranes, tongue and fauces, in cases of gummata, visceral syphilis and most syphilitic nervous affections, the great remedy is not mercury, but iodide of potassium. For late secondary and early tertiary symptoms a favourite combination is that of small doses of corrosive sublimate with iodide of potassium. Professor Bartholow, however, considers the administration of the two drugs in the same mixture a mistake, and gives them separately and alternately, so allowing the iodide to be diffused through the system before the mercury is given (B. M. J., i., 1884). Dr. MacNaughton Jones speaks highly of the bityanide of mercury in doses of $\frac{1}{12}$ gr. combined with quinine and arsenic in the form of pill, for delicate patients, especially women (Pract., i., 1885); and the same salt, the cyanide (20 min. of a 1 per cent. solution), has been injected

into the veins of a syphilitic patient when it was desired to produce the constitutional effects of the drug as expeditiously as possible (B. M. J., ii., 1896; Lancet, i., 1899). The late Mr. Berkeley Hill is quoted for the statement that iodides are not curative in tertiary syphilis, and that mercurial inunction is preferable. After a hot bath, 1 dr. (or less) of a lanolin preparation is rubbed in thoroughly over the whole body for six days in the week till forty-two baths are taken (unless special symptoms require modification), then, after a rest, a second similar course may be required. Care is prescribed as to clothing, and astringents are used to the gums. Cases of serpiginous ulceration, necrosis and gummata are said to yield to this, after failure of other treatment; any resulting anæmia is treated by iron (Lancet, i., 1893).

In *syphilitic iritis* and *retinitis* the early and sufficient use of mercury is more clearly indicated than in any other inflammation, and they are the only conditions in which Ricord held salivation justified. Watson has graphically described how effused lymph in the anterior chamber may be seen to "melt away," under the influence of the drug. I often combine with its internal use collyria of corrosive sublimate, 1 to 2 gr. in 6 oz. of water with opium, or an ointment of ammonio-chloride with belladonna for frictions round the orbit, with good success; but the same treatment cannot be depended upon in rheumatic or traumatic cases. In "*serous iritis*" (chronic) Mr. B. Carter objects to the rapid administration of mercury, but gives $\frac{1}{16}$ gr. of perchloride thrice daily, with local application of discs containing $\frac{1}{2500}$ gr., which may be placed on the conjunctiva night and morning, ten minutes after a cocaine disc (Lancet, i., 1893).

In *syphilitic laryngitis* also, mercury must be promptly and freely used, for in acute cases life is rapidly endangered. Syphilitic infants, as a rule, develop only a subacute form of this disease, which may be treated less actively by moderate frictions with very satisfactory result. A good general treatment for congenital syphilis is to rub a piece of blue ointment about the size of a pea into the side of the abdomen or chest every day.

A germ theory to account for the action of mercury in syphilis has been advanced, and the benefit of mercurials, whether applied locally or given internally, is supposed to be due to their germi-

cidal action. The general likeness of syphilis to the acute exanthemata would suggest a similar bacterial origin; Dr. Lustgarten of Leipsic found, in fact, small groups of slightly curved bacilli very like tubercle bacilli, while M. Briçon and others have described a micrococcus as the cause of the disease.

Scrofula.—In this disease small doses of mercury are useful. I know that this is not so commonly recognised, but $\frac{1}{2}$ or 1 gr. doses of hydrarg. c. cretâ twice daily will often be found of great advantage in purulent discharges from the eye, ear, etc., as also in chronic glandular swellings. Sir Douglas Powell considers that in the early stages of miliary tuberculosis of the pia mater or peritoneum the treatment by small doses of mercuric with potassic iodide should be tried, and he has recorded cases in which such treatment produced good results; this should be done even if there be no syphilitic taint. Dr. Andrew believed that cases of phthisis which are originated by syphilis were more numerous than usually supposed, and recorded a case in which there were signs at both apices, which rapidly recovered under treatment with corrosive sublimate (Lancet, i., 1884). Ananiin, however, gave corrosive sublimate hypodermically and by inhalation in numerous cases of phthisis, without any good resulting.

Hepatitis.—Annesley recommended in this inflammation large doses of calomel to the production of salivation, which he looked upon as “derivative,” and no doubt at one time, as Maclean observes, “faith in calomel may be said to have attained in India to the dignity of a dogma.” He himself strongly objects to any systematic use of mercury, and suggests that if it has gained credit for preventing suppuration this has been in cases which were really of “*peri-hepatitis*,” and not likely to end in abscess; in a large experience he has never seen it arrest suppuration and “disbelieves in any such power” (Reynolds’ System, vol. iii.). Morehead and Waring agree in this opinion, and Massy reports serious impairment of health after its free exhibition. These authors may be taken as representing the present state of general opinion, but I think they have been too strongly prejudiced against the remedy by its excessive use or abuse, and that small continued doses, stopping short of any full physiological effect, may still be found of advantage in commencing hepatitis; occasionally larger (purgative) doses act well. In chronic forms

of inflammation of the liver when the viscus is large and tender mercury is also suitable, though if marked cachexia be present, or suppuration be fully developed, the drug is better avoided.

Cirrhosis.—Monneret has strongly recommended moderate doses of blue pill in cirrhosis with dropsy (Archives Gén., 1851), stating that after the numerous stools and copious sweatings induced, effusions are often absorbed without any ill effects from salivation. Barallier corroborated this experience, and further reported a case, not far advanced, which was cured by this treatment (Dictionnaire). I have sometimes had very good results from mercury in cirrhotic dropsy, but have generally used purgative doses of blue pill, or calomel followed by salines, and in the intervals of purgation have given nux vomica and other tonics. Under such treatment large abdominal effusions have passed away six times in one case, at different intervals, so that the patient was restored to comparative health for some time, and this without any ill effects from the mercury. The diagnosis was verified post mortem, but I have never seen the malady permanently cured by this or any other treatment. In a case, diagnosed as hypertrophic cirrhosis, in a man *æt.* thirty, jaundiced for nine months in spite of treatment (including potassium iodide), and who had enlarged liver but no ascites, calomel was given in $\frac{3}{4}$ gr. doses six times a day for three days, and then omitted for three days; he began to improve at once and was free from all symptoms in three months (B. M. J., i., 1893, Epit.; *cf. ib.*, ii., 1888).

Cardiac Dropsy.—**Venous engorgement.**—In this serious condition good results may be obtained by mercurials either in purgative or diuretic doses, often in combination with digitalis and squill. Sir R. Quain long ago published striking cases. More recently W. Murray recorded one with valvular disease, dilatation and general serous effusion, *in extremis*, but saved by 3 gr. of pil. hydrarg. given thrice daily, and then continued nightly for ten years—relapsing on its omission (Lancet, ii., 1895). Dr. A. Foxwell's patient with advanced double aortic disease was restored by $\frac{1}{3}$ gr. calomel every two hours, which soon caused diuresis (*ib.*).

A method which has been systematised by Finkelstein consists in the exhibition of from $\frac{1}{5}$ to $\frac{4}{5}$ gr. of calomel every two hours, that is, from 1 to 5 gr. daily in small and frequently re-

peated doses for a period of four or five days, and combining the calomel with small doses (from $\frac{1}{4}$ to $\frac{1}{3}$ gr.) of the powder of digitalis leaves. He states that mercurialisation or purgation either rarely resulted or readily ceased on abandoning the drug for a time, and that the diuretic effects continued for a week or ten days after calomel had ceased to be administered. The diuretic effect usually manifested itself on the fourth or fifth day and the quantity of urine voided often amounted to 7 litres or about 12 pints during twenty-four hours (Lancet, ii., 1899).

Dr. Wallace Beatty (Dub. Journ. of Med. Sci., Oct., 1899) administers the drug almost exclusively for its diuretic action, in small doses frequently repeated. He gives a pill containing $\frac{1}{2}$ gr. of calomel, usually with digitalis and squill, every four hours, night and day, for from ten to fourteen days. If these cause purgation, he gives them combined with opium. After five or six days, improvement generally shows itself, with a free flow of urine, as much as 100 oz. in the twenty-four hours. At the end of fourteen days the gums may be a little sore; the mercury is then stopped, and iron ordered, combined or not with digitalis, according to the condition of the pulse. He points out that, as mercury stimulates the salivary glands, it is probable that a similar action on the renal epithelium accounts for the increased secretion. Yet this does not appear to fully explain its effect in cardiac dropsy, as the increased flow of urine only continues as long as there is dropsical fluid to be absorbed. Mercury may, therefore, act by increasing the activity of absorption, but it is not likely that its action is exclusively one of that nature: it increases at the same time the activity of renal secretion. In some cases mercury is not well borne, but these are exceptional.

The following are the cases in which it does most good: The most typical condition is one of general venous engorgement due (1) to chronic primary mitral valve disease; (2) Dependent upon mitral incompetence secondary to old-standing aortic regurgitation; (3) Cases of dilatation of the heart with general dropsy, but no obvious valvular or kidney disease; (4) Failure of the right heart, caused by emphysema and bronchitis; (5) Cardiac dilatation following upon long-continued hypertrophy of the left ventricle.

Jendræssik was an earlier observer of the benefit and of the active diuresis produced by calomel, especially in cardiac dropsy—he gave 1 to 4 gr. two or three times daily, often with jalap—and noted that similar diuresis did not occur in healthy subjects, nor in pleuritic effusion, nor in Bright's disease (*Pract.*, ii., 1886). In a later communication he records the most brilliant results in dropsy with cardiac asystole, and attributes the diuresis neither to a stimulation of the heart nor of the kidneys, but to re-absorption of the effused fluid into the blood. The calomel according to Jendræssik forms an albuminate of mercury in the blood, and this encourages osmosis into it. The less albumin the effused fluid contains, the more readily is it absorbed; hence the difference in results in different diseases. He recommends a small dose eight or ten times during only one day at a time (*Deutsch Arch. f. klin. Med.*, Bd. xlvii.).

(It may indeed be stated as a canon that mercury should not be given in cases of Bright's disease, except it may be in a single purgative dose.)

Rosenheim, as the result of perfusion experiments on the excised kidney, comes to the conclusion that the diuresis results from direct stimulation of the renal epithelium (*Ztschr. f. klin. Med.*, xiv., 1888), while Locke attributes it to the increased formation of urea caused by the action of mercury on the liver (*Pract.*, ii., 1886).

Weinstein (*Wien. med. Blätter*, 1887) and Rosenheim (*Deutsch med. Wochenschr.*, 1887), while admitting the diuretic action of mercury in dropsy from various causes, point out that in an undue proportion of these cases there is risk of mercurial poisoning.

Hepatic Congestion.—Constipation.—In torpor, or sub-acute congestion of the liver, marked by a coated tongue, yellowish countenance, headache, nausea, depression and light-coloured stools, a moderate mercurial purge, especially if followed by a saline, will commonly relieve more quickly than any other medication (unless it be sometimes podophyllum), and no amount of experiment on animals can alter this clinical fact. The experience and authority of Murchison quite corroborate this (*Lancet*, 1874). In chronic cases of this kind it is, however, advisable not to resort frequently to this remedy, but to depend

rather upon diet, hygiene, and saline or vegetable aperients, though small doses— $\frac{1}{50}$ to $\frac{1}{20}$ gr. of corrosive sublimate at bedtime—have a good effect. Sir Lauder Brunton considers that the action of blue pill or a few grains of calomel in relieving “biliousness” may be due to the *antiseptic* power of mercurials. So far as relates to calomel, this view has been supported experimentally by Vassilieff, who finds that calomel will prevent the growth of putrefactive organisms in the digestive tract or in artificial digestions, although it has no destructive action on the unorganised ferments which bring about digestion (Zeits. f. physiol. Chem., 1882), and inasmuch as “biliousness” is usually the effect of the absorption of toxic products from the intestine the antiseptic theory seems a probable one.

Vomiting.—In some forms of obstinate vomiting dependent upon a disordered condition of stomach with hepatic congestion, 3 to 5 gr. of calomel in pill or powder have a most beneficial effect; the dose should be followed after a few hours by a saline purge.

Diarrhœa (Infantile).—When the motions are green, curdled, watery and offensive, small doses ($\frac{1}{4}$ or $\frac{1}{2}$ gr.) of grey powder with $\frac{1}{12}$ min. creosote and a little cerium oxalate act very well, especially when combined with bismuth, and the same powders are useful when curdled milk is frequently rejected from the stomach. The unmistakably good effect of mercury in infantile diarrhœa has been ascribed to the antagonising effect it is said to exert on the ptomaine of milk—tyrotoxinon. When there is a simple diarrhœa with whitish stools Dr. Stephenson thinks that rhubarb and soda should replace the mercurial, for fear the latter should depress the strength (Edin. Med. Journ., 1871), and certainly, if it be continued unwisely, it may do so by irritating the mucous membrane, etc., but I have never seen ill effects from the minute doses above recommended. For infantile watery diarrhœa $\frac{1}{100}$ gr. of corrosive sublimate, given with due care after each motion, acts well. I think this is now a common experience; I have acted upon it for twenty-five years. In the acute diarrhœa and colic of adults, one of the best methods of treatment is the use of a pill of calomel (3 gr.) with opium (1 gr. or $\frac{1}{2}$ gr.), followed, after three or four hours, by castor oil or other laxatives.

Dysentery.—In acute dysentery, with violent pain, severe prostration and frequent muco-sanguineous stools, small doses of

corrosive sublimate, given at short intervals, commonly relieve in a few hours, and almost in a "specific" manner—certainly better than any other remedy I have known. Sublimate is equally useful in the "white dysentery" of Ceylon and India. I have seen the best results from it when opium, lead and other astringents have proved useless. I agree with Wood, who asserts that in this malady "no remedial influence is more effective than that of mercury," rather than with Maclean, who deprecates its use in all forms and stages. I can only suppose that the injurious effects traced by him and by others to calomel and other mercurials resulted from doses that were too large. It is possible that the mercury preparations have a poisonous action on the essential cause of dysentery—the *amœba coli*.

Cholera.—Dr. Maclean equally objects to any preparation of mercury in cholera, as "useless in collapse and dangerous when reviving" (*Lancet*, 1866), but although I am not an advocate of the calomel treatment, the results obtained by Dr. Ayre, of Hull, deserve attention. He gave $\frac{1}{4}$ to $\frac{1}{2}$ gr. of calomel every ten minutes or every four hours, according to circumstances; it rarely salivated, but produced apparently good results in a majority of cases. Bloxam and some other observers have followed the same plan with advantage, and Niemeyer speaks well of calomel treatment.¹ What is desired is to stimulate by this means a secretion of bile and to promote elimination, for we know that the re-appearance of bile in choleraic stools is a favourable sign; besides this, large doses of calomel ($\frac{1}{2}$ dr.) have been said "to restore warmth" (*Brit. and For. Rev.*, i., 1870). Köhler thinks that its good effects are owing to the disinfecting property of the drug when brought into contact with the contents of the intestines. Of fifty-six cases, some of which received 200 gr. in two days, twenty-one died, but the reporter seems to think the results favourable to the treatment by calomel (*Lancet*, i., 1874). The general experience of the profession has not, however, adopted it, and it is clearly not free from danger, for under certain conditions a quantity of the medicine may remain for a time unabsorbed,

¹ A pill containing $\frac{1}{4}$ gr. with $\frac{1}{4}$ gr. piperine every ten to twenty minutes till feculent matter appeared in the stools is said to have acted so well in cholera that "not a patient was lost after its adoption, unless previously saturated with opium, or too far gone for medication" (*Lancet*, i., 1893).

and afterwards produce serious toxic effects. Still there exists in favour of its use an undercurrent of opinion, which may be supported by much clinical experience (*cf.* Ewing Whittle and others, B. M. J., ii., 1884).

Intestinal Worms.—Calomel is a suitable vermifuge in cases of ascarides. Both the round and the thread worms are expelled under the influence of 2 to 5 gr., which may be given early in the morning and followed in a few hours by a purgative draught. It is usual to combine the dose with powdered jalap, but I have found the mercurial alone sufficient and it is more readily taken. Dr. Stillé speaks well of the effect of a small portion of mercurial ointment placed in the rectum daily at bed-time for destroying ascarides, also of the injection of $\frac{1}{4}$ to 1 gr. of corrosive sublimate dissolved in water, but I doubt the wisdom of this latter treatment. Holt however endorses it, recommending half a pint of a 1 in 10,000 solution thrown into the colon by a catheter after cleansing by a borax solution—he uses the same for local cleansing after each stool (Dis. Infancy, etc., 1899).

Hypodermic Injection of Mercury.—This method was first adopted by Charles Hunter (1858), who injected perchloride of mercury in watery solution (1 gr. in 1 dr.) twice weekly until 25 gr. had been given; no salivation occurred. In 1860 Hebra and Neumann reported on the method, but did not consider it superior to others. Scarinzi used calomel in glycerin and in water, injecting about 3 gr. each time; he praised it very highly. Lewin (Berlin, 1869) used a solution of mercuric chloride, giving $\frac{1}{8}$ gr. daily, and found that fifteen injections usually sufficed for cure. Since then the hypodermic method has had an extensive trial, and has on the whole given satisfactory results, though we may doubt whether it is more efficacious than mercury given by the mouth, or by inunction. It is claimed that it cures syphilis more rapidly, and that relapses are less frequent than when mercury is given in other ways, that it ensures precision of dosage, does not disturb digestion and is easily given. On the other hand, most of the preparations hitherto used cause a good deal of pain locally, and not infrequently abscesses. In many cases the metal or insoluble salts, such as calomel suspended in oil, vaseline, mucilage, or glycerin, have been given in about 3 gr. doses once weekly; or yellow oxide of mercury in the same menstrua about $\frac{1}{2}$ gr. weekly;

2 or 3 gr. doses have been given with success every ten days in the cellular tissue (Lancet, ii., 1889), but are not so safe as the smaller dose; the insoluble salts are presumed to be more permanent in their effects. "Grey oil" consists of mercury, lanolin and olive oil, and was at one time in vogue in Vienna, and in France (Lancet, i., 1898), while the salicylate, yellow iodide and cyanide were employed in Russia, and the formamide (Liebreich) in Germany. The benzoate has also been used (Lancet, ii., 1891); the sozo-iodolate, $\frac{1}{8}$ gr., once a week (*ib.*, i., 1900), as well as albuminates and peptonates made with corrosive sublimate. It has been claimed that organic soluble compounds act better, are more quickly absorbed and eliminated, and cause less risk of poisoning. Thus v. Mering has recommended mercury-glycocol (Archiv f. expt. Path., 1880), Wolff, mercury-asparagin (Strassburg, 1883), while Hüfler speaks very highly of a peptonate made with gelatine, hydrochloric acid and corrosive sublimate (Therap. Monatsheft, 1890). Vollert has used for a large number of cases mercury succinamide in a 2 per cent. solution, giving an amount equal to about $\frac{1}{6}$ gr. of metallic mercury daily, and states that twenty-four injections usually suffice for cure, and that his results are uniformly good (Therap. Monatsh., 1888 and 1890).

The hypodermic method does not lessen the risk of mercurialisation, for a large number of cases have been reported, and even deaths. Kraus gave $\frac{1}{8}$ gr. of calomel subcutaneously to a labourer, aged thirty, suffering from recent syphilis, and seven days afterwards a similar dose; on the eighth day stomatitis was observed, and on the thirteenth day death occurred after typical symptoms of mercurial poisoning which were confirmed *post mortem* (Deut. med. Wochenschr., 1888). Kuneberg has collected seven fatal cases under larger doses (*ib.*, 1889) and Watraszewski considers that only up to $\frac{2}{3}$ gr. is practically safe. With the "grey oil," stomatitis and also several cases of fat-embolism in the lungs are on record, and he finds yellow oxide ($\frac{2}{3}$ to 1 gr.) the best, and has given it "thousands of times" without ill effect; mucilage is the safest vehicle, 1 part to 120 water; with oily vehicles there is risk of embolism or pneumonia if a vein be pierced in intra-muscular injection (Lancet, i., 1890). Bloxam recommends in syphilis the *intra-muscular* injection of sal alembroth, which should not contain an excess of chloride of ammonium. The

solution is made by dissolving 32 gr. of perchloride of mercury with 16 gr. of pure chloride of ammonium, in water sufficient to yield 2 fl. oz. of product; 10 min. of this equal $\frac{1}{3}$ gr. of the salt. It keeps well, is clear and not liable to fungoid growths or precipitation. The injection should be made deeply into the muscles of the buttock, changing sides alternately; the quantity should be 10 min., and the patient should be injected once a week. He used this injection upwards of 900 times; it caused little or no pain and no induration at the seat of puncture unless blood was extravasated. (Any pain from these injections is said to be lessened by guaiacol (Pract., ii., 1899).) In only four of these cases slight mercurialism was produced: in none had abscess followed. The primary lesion usually healed after a few injections, and the sequelæ, in some cases extremely severe, were at once arrested. The effect on the eruptions was most marked; in seven to eight weeks the most obstinate skin manifestations melted away, the throat and glands alone remaining as evidence of the disease. From this period the injection was only used once a fortnight until nearly all the symptoms had disappeared; then the patient was injected only once a month, the treatment being continued for twelve to eighteen months (Lancet, i., 1888). Surgeon-Major Lambkin, who ceased injecting perchloride or sal alembroth because of the pain they produced, speaks very highly of intra-muscular injections (gluteal region) of a mercurial cream made with mercury, ʒij; lanolin, ʒij; carbolic oil (2 per cent.), ʒi; maximum dose 10 min. He used this 6,000 times without accident, but as it varies in consistence with the temperature he recommends rather Hydrarg. sozo-iodol, gr. v; Sodii iodidi, gr. x; Aq. destil., 200 min.: dose 10 to 15 min. (B. M. J., i., 1898). The average treatment was by one injection weekly continued for several months. Dr. Althaus claimed priority in the use of the cream, and says that if properly made—1 part of mercury with 4 each of lanolin and carbolised oil—it keeps in perfect condition, is less painful than the last mentioned, and more permanent in effect as being almost insoluble; it is more slowly absorbed and eliminated (*ib.*). The method of the *intravenous* injection of mercury to which reference has been made can hardly be regarded as an improved method of treatment and it is in my opinion a procedure open to very great risks. Still many good results are recorded, as by A. Chop-

ping, who injected 20 min. of a 1 per cent. solution into a vein of the arm every day in eighty-four cases (Lancet, i., 1899), and E. Lane speaks well of its use in seventy-six cases (*ib.*, ii., 1896).

Fournier¹ advocates the employment of calomel injections in syphilis, not as a routine treatment, but as an exceptionally powerful one to be used in certain severe conditions, such as spinal and cerebral syphilis, iritis, phagædena, chronic palmar and plantar syphilides, ulcerating tuberculous syphilides, glossitis, and tertiary laryngeal and pulmonary syphilis. It should be regarded as a temporary measure to be used for one or two months till the severe condition is improved, when it should be replaced by more ordinary treatment.

The technique is as follows :—The calomel should be sublimed, not precipitated, and afterwards washed with boiling alcohol and dried. The best vehicle for solution is sterilised olive oil. A Pravaz syringe is used holding a gramme which contains 5 centigrammes of calomel. The needle is introduced deeply into the gluteal muscles, and a slight interval allowed to elapse before the injection is made, to see if any blood appears. If this occurs the injection should not be made in that place, since there is danger of pulmonary embolism. The average dose is 5 centigrammes, which may be injected every seven or ten days, and increased to 7, 8, or 10 cgms. if necessary. In women 3 or 4 centigrammes are enough.

The author remarks on the rapid action and beneficial results in many cases, and quotes several severe cases which were cured by a few injections, sometimes by only one. Four or six injections are usually sufficient. On the other hand such good results do not always follow, and sometimes the method fails.

The objections to this, as to the other methods, are the occasional occurrence of stomatitis, gastro-enteritis, toxic effects, local reaction, and pain. With doses of 5 centigrammes bad mercurial symptoms are rarely seen; swelling and induration of the buttocks are frequent, but abscess is rare. Pain is the chief complication, and occurs in three out of five injections. It is sometimes very severe, but the method should not be abandoned on that account in the intractable cases in which he recommends it.

Hillier² prefers hypodermic injections of perchloride of mer-

¹ Rev. de Thérap., 1st November, 1900; B. M. J., December, 1900.

² Wien. klin. Rund, No. 5, 3rd February, 1901; B. M. J., February, 1901.

cury. His formula is hydrarg. perchlor. and sodii chloridi, of each 1·2 gramme in 189 c.cm. of water. Two c.cm. are injected daily for two weeks, with a day's interval after each six injections. In the third week two days' rest is given; in the fourth week injections are made on alternate days, and after this twice a week. As a rule thirty injections are enough, but sometimes forty or fifty are required. The injections are made into the gluteal muscles. The pain is inconsiderable. The author pays special attention to disinfection of the skin before each injection, and uses successively the razor, soap and water, perchloride of mercury lotion, and alcohol.

Inunction.—The patient should be prepared for a course of mercurial inunction by simple dieting and by warm baths: and during it should be clothed in flannel and avoid exposure. When making the frictions himself, he should rub thoroughly in his hand the prescribed quantity of ointment, and then slowly and forcibly anoint certain parts of the body in a definite order: it is usual to choose the axillæ and the groins, but practically it is better to avoid parts with abundant hair follicles. According to the German method of Zeissl, the inner side of both upper arms is first treated, on the next night the inner side of the thighs, then of the forearms, then of the legs, afterwards of the groin and of the back, so that an interval of several days is allowed between the friction of any one part, in order to avoid local soreness. The evening is the best time for the application, and warmth promotes its effect: the part should be kept covered during the night, and be cleansed on the following morning. When the patient is too ill, or for any reason is unable to apply the ointment himself, the attendant who uses it should protect his own hand with a leather or caoutchouc glove. (A professional rubber of mercury reports thirty-seven years of good health (*Lancet*, i., 1896).) In young children frictions are often made on the inner side of the soles of the feet, or a piece of ointment is simply placed on the inner side of a thin flannel binder. For adults $\frac{1}{2}$ dr. up to 2 dr. represents an average amount of mercurial ointment for daily use, but sometimes, as in peritonitis, 1 dr. has been ordered every hour: it is important that no rancid ointment be used, or severe irritation may be induced by it.

This method of treatment has the advantage of saving the

digestive tract from any direct irritation by the drug, and, according to Sir B. Brodie, "it cures better and injures the constitution less." This, however, scarcely holds true in view of the modern cautious administration of mercury, and the method of inunction is less often adopted than formerly, since it is, at the best, troublesome and uncleanly: neuritis has been attributed to it. Blue ointment is the one usually chosen for inunction, but the oleate is now often used. Dr. Shoemaker considers it to be the best mercurial ointment for other purposes as well. Dr. Detmold recommends that a solution of corrosive sublimate should be used instead of ointment; it is made with water (1 gr. in $1\frac{1}{2}$ oz.), and this is rubbed on the extremities in turn, every night and morning; except for occasional griping pain, he obtained good results (Boston Med. Surg. Journ., 1884). Schuster finds Oberlander's soap (made with mercury and potash) the best form, since less friction is required, but Nega points out that it is not always well made and on the whole prefers the "grey ointment" of the French Pharmacopœia (Rev. Gén., xxviii., 1886). Unna's mercury salve soap, containing half its weight of mercury ("grey soap"), is a good form: $\frac{1}{2}$ to 1 dr. may be used daily and left on the skin for a week at a time.

The *endermic* application of mercury is effected by dressing a blistered surface with blue ointment, or sometimes with calomel. From the latter, purging has resulted, but as a rule the endermic method is employed for a local stimulating action on the absorbents, as in pleuritic, pericardial or joint effusion, rather than to affect the general system. Ahman's method is the wearing round the body of porous bags (Weiland's) containing mercuriol, which is an amalgam with alum and magnesia in fine amorphous particles, containing 40 to 80 per cent. of mercury; 5 grammes are used daily (B. M. J., ii., 1899; Lancet, i., 1900).

The **Mercurial Vapour Bath** is the best method of application for some cases, especially of syphilitic cutaneous disease. In it calomel or sulphide of mercury is vaporised in conjunction with steam, and becomes deposited as finely divided powder on the body of the patient as he is seated unclothed over the lamp. Care should be taken that the vapour be not inhaled, or profuse salivation may occur.

PREPARATIONS AND DOSE.—*Hydrargyrum cum cretâ* (contains 1 part of the metal to 2 of prepared chalk, rubbed together until globules cease to be visible): dose for children, $\frac{1}{2}$ to 2 gr., less or more; for adults, 1 to 5 gr., or less. In warm climates grey powder is rapidly oxidised, red oxide of mercury being formed, and this has sometimes led to dangerous symptoms of poisoning. Surgeon-Major Cookson recommends either heavy or light magnesia as a better admixture than chalk with the mercury in these countries (Lancet, ii., 1884). Dr. F. Macnamara recommends that the grey powder should be mixed with an equal amount of white sugar to prevent such oxidation (Med. Times, i., 1885). *Pilula hydrargyri* (contains 2 parts of the metal with 3 of confection of roses, and 1 of powdered liquorice root): dose, as a purgative, 4 to 8 gr.; for constitutional effects, 2 to 3 gr. three times daily—may be well combined with quinine. *Emplastrum hydrargyri* (made with mercury, olive oil, sulphur, and lead plaster). *Emplastrum ammoniaci cum hydrargyro* (contains gum ammoniac in place of lead plaster, or in other words, ammoniacum and mercury plaster). *Unguentum hydrargyri* (mercury rubbed up with prepared lard and suet). *Unguentum hydrargyri compositum* (contains mercurial ointment, yellow wax, olive oil and camphor): this is used as a stimulant to swollen glands, and for chronic inflammation of joints, and represents “Scott’s ointment”. Mercurial plasters and salve “mulls” are also prepared from German formulæ. *Linimentum hydrargyri* (contains blue ointment, solution of ammonia, and camphor liniment): it should be a lead-coloured cream; this readily produces salivation.

Hydrargyri subchloridum: dose as a purgative for children, $\frac{1}{2}$ to 2 gr.; for adults, 2 to 5 gr.; for constitutional effects, $\frac{1}{2}$ to 1 gr. or more, frequently repeated, or $\frac{1}{12}$ gr. may be given every hour (3 to 4 gr. in this manner sometimes produce mercurial action), or $\frac{1}{4}$ to $\frac{1}{2}$ gr. or more may be given night and morning, combined with a fractional quantity of opium. *Lotio hydrargyri nigra* (contains 3 gr. of calomel, with glycerin and tragacanth, to the ounce of lime-water). *Pilula hydrargyri subchloridi composita*—Plummer’s pill (contains calomel, sulphurated antimony, guaiac resin and castor oil): each 5 gr. of the pill mass contains 1 gr. of calomel and 1 gr. of sulphurated antimony; calomel should not be given with alkaline carbonates, as corrosive sublimate is liable to be formed. *Unguentum hydrargyri subchloridi* with benzoated lard (10 gr. of this ointment contain 1 gr. of calomel). *Hydrargyri perchloridum*: dose, $\frac{1}{32}$ to $\frac{1}{16}$ gr. in solution or in pill; but very much smaller doses are used. *Liquor hydrargyri perchloridi* (contains $\frac{1}{2}$ gr. of perchloride to each fluid ounce, or $\frac{1}{16}$ gr. to the drachm): dose, $\frac{1}{2}$ to 1 dr., i.e., $\frac{1}{32}$ to $\frac{1}{8}$ gr., but I prefer smaller doses, as mentioned above. *Lotio hydrargyri flava* (contains 20 gr. of corrosive sublimate in 10 oz. of lime-water).

Unguentum hydrargyri ammoniaci: 1 part of ammoniated mercury in 10 of white paraffin ointment.

Hydrargyri iodidum viride (not official): dose, $\frac{1}{2}$ to 3 gr. *Hydrargyri iodidum rubrum*: dose, $\frac{1}{32}$ to $\frac{1}{8}$ gr. *Unguentum hydrargyri iodidi rubri*: 1 part in 25 of ointment (4 per cent.).

Hydrargyri oleas. *Unguentum hydrargyri oleatis* with benzoated lard (1 in 4). *Hydrargyri oxidum rubrum*: for external use. *Unguentum hydrargyri oxidi rubri* in paraffin ointment: 1 gr. of red oxide in 10 gr. of the ointment. *Unguentum hydrargyri oxidi flavi* (1 to 50 soft paraffin).

Hydrargyri nitratis liquor acidus: used externally. *Unguentum hydrargyri nitratis* (citrine ointment): 1 part in 16 $\frac{1}{4}$. *Unguentum hydrargyri nitratis dilutum* (1 part citrine ointment to 4 parts soft paraffin).

Hydrargyri sulphuratum—"artificial cinnabar" (not official): not used internally. Its fumes are used in syphilitic skin diseases, as *ecthyma*; also, in syphilitic sore throat by inhalation, 30 gr. being heated on an iron plate and placed under the patient, who should be wrapped in a blanket; or the vapour may be inhaled through a funnel.

Of non-official preparations, *hydrargyri tannas* is well spoken of as an antisyphilitic; it contains 50 per cent. of mercury, which is set free by alkalis: dose, 1 to 2 gr. (B. M. J., ii., 1886). *Hydrargyri carbolas*: dose, $\frac{1}{4}$ to 2 gr. (v. p. 697). *Hydrargyri salicylas* is given internally as an antisyphilitic (dose, $\frac{1}{4}$ gr.), and is used also as a dusting powder or ointment in specific sores. *Hydrargyri succinimidum*. In syphilis it is used as a hypodermic injection—2 per cent. solution: dose, $\frac{1}{4}$ gr. A 1 per cent. solution of cocaine may be added to prevent pain. *Hydrargyri naphtholactas*; used for healing wounds and as antisyphilitic: dose, $\frac{1}{2}$ to 1 gr. *Hydrargyri thymolacetas*: used as an intra-muscular injection (1 in 10 of liquid paraffin in syphilis); also in pills: $\frac{3}{4}$ to 1 gr. *Hydrargyri cyanidum* (not official): dose, $\frac{1}{16}$ to $\frac{1}{12}$ gr., twice daily; used also in lotion. *Double cyanide of mercury and zinc* (solubility in water 1 in 1,200) kept corpuscles and blood serum permanently free from putrefaction: although an inhibitor of putrefaction, is not a powerful germicide; it is quite unirritating (B. M. J., ii., 1889). Gauze and wool containing 3 per cent. of this salt are in use. *Foramidate of mercury* is neutral, soluble in water, does not coagulate albumin, and is not precipitated by alkalis (v. p. 700).

Sal alembroth—(Syn. *double chloride of mercury and ammonium*—*Ammonio-mercuric chloride*). A salt of mercury in which one molecule of mercuric chloride is combined with two molecules of chloride of ammonium; it contains two-thirds of its weight of the former, is soluble in less than its own weight of water, and is a powerful antiseptic. It is used to prepare: *Alembroth gauze* (blue), containing 1 per cent. The gauze should be damped with a lotion of 1 in 40 of carbolic acid before application as a dressing. *Alembroth wool* (blue), containing 2 per cent. *Alembroth gauze and cotton wool tissue* (blue), containing 2 per cent. (chiefly used for eye cases). *Mercuriol* is an amalgam containing 40 per cent. or more. *Mercuriol* is a proteid compound (Lancet, i., 1900).

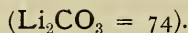
LITHIUM, Li 7 (6.97). (*Not official.*)

This metal has not been found native. It occurs in the mineral kingdom as an oxide, chloride, silicate, or fluoride with potassium and aluminium (the lepidolite or rose mica of Bohemia). Bunsen and Matthiessen isolated it by means of electricity (1855).

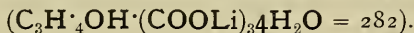
Supposed at one time to be found in minerals only, it was named *λίθος*, stony, but it is now recognised not only in many mineral waters, but in seas and rivers, vines and many fruits, the ashes of plants, and in most of our vegetable food. The "Buffalo" water is said to contain 2½ gr. in each gallon (Record, 1885).

CHARACTERS.—It is soft, silvery-white and easily oxidises: it floats upon water, and is the lightest known metal, the specific gravity being 0.5936.

COMPOUNDS OF LITHIUM.

LITHII CARBONAS—LITHIUM CARBONATE

CHARACTERS.—It occurs in the form of a white powder or crystalline grains, having an alkaline taste and reaction: it is insoluble in alcohol, but slightly soluble in water (1 part in 150, or about 4 gr. to the ounce): carbonic acid increases the solubility to 5 parts per 100. Hoffman has published some exact observations as to the solubility of and tests for carbonate of lithia (Lond. Record, 1886).

LITHII CITRAS—LITHIUM CITRATE

CHARACTERS.—A white amorphous powder, anhydrous, deliquescent on exposure, entirely soluble in two and a half times its weight of water: it is somewhat unstable in composition and requires to be carefully kept from the air.

LITHII CITRAS EFFERVESCENS.

CHARACTERS.—Is a granular effervescent preparation of sodium bicarbonate, tartaric and citric acids, and lithium citrate. Two drachms contain about 5 gr. of the lithium salt. There is also an acid tartrate.

The *urate* and *hippurate* occur in small white crystals which are very soluble. The *guaiacate* is prepared by digesting guaiacum resin with a watery solution of lithia, and evaporating. The *benzoate*, which is prepared from the carbonate by adding benzoic acid to the hot solution (Pharm. Journ.,

July, 1875), occurs in glistening pearly scales, of soapy feel, acid reaction and cool sweetish taste: it is soluble in three and a half parts of cold water, and ten of alcohol—it is thus more soluble than the carbonate whilst it is more stable than the citrate, and has the advantage of containing an acid (95 per cent.) itself valuable in the treatment of urinary deposits.

A *ferruginous benzoate* of lithium has been prepared by M. Trehyon (*Progrès Médical*, 1874) and is recommended both as a non-irritant form of benzoic acid, and as a tonic and preventive of the anæmia produced more or less by all alkalies.

The *bromide* may be prepared by direct combination, and obtained in transparent crystals which are deliquescent, neutral and of sharp, bitter taste. It contains a large proportion of bromine (62 per cent.), whilst the analogous salt of potassium contains only 66, and of sodium 78 per cent.

The *salicylate* is a white deliquescent powder of sweetish taste and acid reaction, soluble in water and alcohol. It is presumed to unite the properties of salicylic acid and lithia in the treatment of gout and rheumatism. The glycero-phosphate of lithium is in white amorphous powder, freely soluble in water; the sulpho-ichthyolas resembles ichthyol.

ABSORPTION AND ELIMINATION.—Lithium salts are rapidly absorbed: thus, from the experiments of Dr. Bence Jones, it appears that if 3 gr. of the chloride be given to an animal on an empty stomach, it may be detected even in the cartilage of the hip-joint and the aqueous humour of the eye in a quarter of an hour: 7 gr. having been given to a parturient woman eight hours before delivery, it was afterwards detected in every part of the umbilical cord, and 20 gr. of the carbonate having been taken three and a half hours before an operation for cataract, ample traces of lithia were detected in the lens when removed; four days afterwards it could still be detected in the secretions, and was not wholly eliminated till the end of seven days. It is excreted chiefly by the kidneys.

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—Lithium salts act much like the alkalies potassium and sodium upon the gastric secretions,—the carbonate especially is a direct antacid. Small doses are readily borne, but doses of 30 to 50 gr. of the carbonate—such as were used by Charcot—give rise after a few days to cardialgia and dyspepsia. Rabuteau also states that, though he at one time recommended 15 to 30 gr. per diem, his later experience proved that dyspepsia and even vomiting were caused by these quantities. Climent records similar results in his own person (*Traitement de la Gravelle*,

Thèse, Paris, 1874), and although lithiated waters—*e.g.*, at Baden-Baden—at first improve the appetite and digestion, they give rise to sickness and diarrhœa if taken in excess.

Circulatory System.—Carbonate of lithium increases the alkalinity of the blood more quickly than compounds of potassium or sodium. The same salt given in large doses (80 gr.), rapidly diminishes the number of red blood corpuscles and induces anæmia, like the alkaline carbonates. A much less quantity than 80 gr. seems to exert a depressant effect on the heart in weakly subjects—it in this respect again resembling potash in its action, but it does not as a rule depress so much as that salt. Several observers agree in the conclusion that bromide of lithium, a salt with especially sedative powers, exerts a less lowering effect upon the heart than bromide of potassium (Roubaud, Archives Gén., i., 1875; Lévy, Gaz. Méd. de Paris, 1875), but frogs and some warm-blooded animals may die under toxic doses of lithia, with cardiac arrest in diastole (Husemann, Hesse). Dr. Nikanoroff has investigated the action of lithium salts on animals. In frogs the heart is stopped in diastole, but not so readily as by potassium compounds, and its excitability remains intact for some time after it has been stopped; division of the vagi or of the spinal cord does not alter this result; there is also dilatation of bloodvessels. In mammals the effects are somewhat different; the heart is but little affected and there is a rise of arterial pressure; diuresis, and, after large doses, albumin and hæmoglobin occur in the urine. He concludes that the drug is more allied to soda than to potash (Record, 1884).

Nervous System.—Lithia is said to depress the general nervous power, and a slight degree of tremor or twitching has been sometimes noticed under its continued use, but I am not aware of any serious effects of this kind. The action of lithium upon muscles, nerves and nerve centres is very much like that of potassium, but is more powerful; some patients feel the lowering effects markedly.

Urinary System.—The quantity of urine is generally increased by lithia, but analyses are not uniform as regards solid urinary products. Thus M. Levy, using the bromide of lithium in gouty subjects, found the excretion of urea and uric acid rather lessened. In healthy subjects, however, Moss found

both the liquid and solid constituents of the urine much increased (Amer. Journ., April, 1861). Diuresis is usually a marked effect of it; one or two doses of 1 to 4 gr. may not produce it, but if continued they do so, and commonly render soluble any deposit of urates. In some persons one bottle of lithia water (about 4 gr.) will cause copious secretion, but the effect varies somewhat, possibly according to the amount of acid in the system. Sir A. Garrod found lithia more active in this respect than potash, 20 to 30 gr. of the former citrate equalling 2 to 3 dr. of the latter. Moss corroborated this (*loc. cit.*). Nikanoroff found the chloride more diuretic than the acetates, but the amount of uric acid excreted under it was unchanged.

Benzoate of lithium seems to have special powers in this respect, for it is very soluble, and the benzoic acid, changing in the system into hippuric acid, combines with alkalies to form hippurates, which are more soluble and more readily eliminated than urates; benzoic acid has also a direct solvent action on urates. The diuretic action of any salt of lithium is much increased by free dilution.

SYNERGISTS.—Lithia is akin to potash, soda and alkaline earths generally, but the characters of some of its salts indicate a special chemical analogy with magnesia. Thus, the carbonate is decomposed by heat, requires 100 parts of water for solution, but is more soluble in presence of carbonic acid: the phosphate is insoluble, the chloride and nitrate are deliquescent; there is no alum or bisulphate. Agents promoting waste, such as mercury and the iodides, also favour the constitutional action of this and allied medicines.

ANTAGONISTS AND INCOMPATIBLES.—Acids, acidulous and metallic salts. Salts of sodium are sometimes prescribed with lithia, but there is some evidence that they are therapeutically incompatible. Mendelsohn found the chloride of sodium markedly lessen the solvent action of it on uric acid, and Sir William Roberts and others have been so satisfied on this point as to disallow common salt in rheumatic and gouty subjects. Phosphate of soda in the urine might form with lithia salts an insoluble triple phosphate (*v. p.* 738).

THERAPEUTICAL ACTION.—*External.*—**Gouty Concretions.**—**Stiff Joints.**—These may often be well treated by a lotion

containing about 5 gr. of any soluble lithium salt in the ounce of rose-water, kept constantly applied on lint, covered with oiled silk. I have generally combined this application with the occasional local use of iodine and the internal administration of lithia with massage, and have known the concretions and the stiffness to be removed. A pomade containing oleo-stearate of lithium has been recommended for friction in similar cases (Duquesnel). Lithia lotions are useful also if the skin be broken near gouty joints. Such sores do not readily heal, because the urate of sodium permeates the connective tissue near them, and an alkaline salt neutralises the acids and promotes healing.

THERAPEUTICAL ACTION.—*Internal.*—**Gout.**—During acute gout lithia is often useful as an adjuvant or an alternative to alkalies or colchicum, but it is during the intervals, when the urine is loaded and the joints obscurely painful, that the habitual use of small quantities is most advantageous. According to Sir A. Garrod it lessens the frequency of the attacks, diminishes uric acid deposits, sometimes causes the absorption of concretions, and even wholly removes the gouty dyscrasia. Reasoning from the power of lithia in warm solution to dissolve uric compounds out of gouty bone external to the body, he presumes that it can exert an analogous effect within the system, and favour the elimination of the *materies morbi* in the form of urate of lithium. Wagner found, after ample experience, that treatment by lithia shortened the duration of acute attacks, and prolonged the intervals of freedom: it relieved pain and promoted elimination by diuresis. He gave from $\frac{1}{2}$ to 5 gr. doses of the carbonate in an aromatic bitter, continuing them during the interval between the attacks for many weeks (Schmidt's Jahrb., i., 1875). Stricker reports a case in which gouty concretions on the finger-joints disappeared in a few weeks under a course of it (quoted by Garrod). Ditterich, whilst estimating the remedy highly, would restrict its use to chronic forms of gout or chronic illness of any kind, if dependent upon excess of uric acid. He found that doses of 5 to 10 gr. were liable to induce dyspepsia, and recommended not more than $1\frac{1}{2}$ gr. for a single dose, or 15 gr. in twenty-four hours; he generally observed relief in seven to fourteen days without drawback (Schmidt's Jahrb., 1870). When acidity of the stomach is present the carbonate should be given, because it is a more

direct antacid than the other salts ; if, however, there is no marked gastric derangement, the neutral citrate is to be preferred ; it is decomposed within the system, and eliminated as carbonate in the urine. The Ballardvale lithia spring (Mass.) has $\frac{3}{4}$ gr. of carbonate in the pint (B. M. J., ii., 1897). The ferruginous benzoate of lithia is much recommended by Dalkiewicz (in his essay *Sur la Goutte*, 1873), by Malley, and other French physicians (Record, 1874). For gingivitis, depending on a gouty diathesis, the acid tartrate has been found specially good (Lancet, i., 1894).

The Baden-Baden waters, though valuable in gout and in gouty headache, concretions, etc., are said to increase the joint pains during their early use (Althaus). There is one spring, the Murquelle at Baden-Baden, which is distinguished for a considerable quantity, *viz.*, 0.4 gr. of the chloride of lithium in 16 oz. Next to the Murquelle is the Fettquelle, in the same place, with 0.23 gr. of chloride of lithium, and a spring in Elster, with 0.76 of carbonate of lithium.

With the exception of Sir A. Garrod's writings, there are but few English observations on the treatment of gout by lithia, though the remedy must be largely used. It does not always give the satisfactory results that have been claimed for it, and some practitioners are still sceptical as to its real value. A proprietary compound with saline aperients, Thialion, is one of the most effective forms.

In the well-known experiments of Sir William Roberts for testing the effects of various salts in delaying or hastening precipitation of uric acid from definite solutions of it in serum the salts of lithium "had not the slightest influence either way"; and whilst this authority sanctions the use of lithia in acute attacks "when colchicum and other remedies fail," and says they are extensively employed in chronic gout, yet he points out that they cannot dissolve sodium biurate like uric acid, and that, "if they exert any beneficial effect, it is certainly not due to any solvent action on the material of gouty concretions" (C. Allbutt's System, vol. iii.).

Dr. Luff, also working with test tubes, found that lithia salts had no effect in increasing the solvent power of the blood for gouty deposits, nor in delaying the conversion of quadriurate into biurate of sodium (On Gout, 1898).

Siebold denies that lithium salts are superior to potassium in the treatment of the uric acid diathesis. He points out that it follows as a matter of course from the relative atomic weights of lithium and potassium that the former is capable of saturating nearly twice as much uric acid as the latter; further than this it has no specific action, and he argues that one has only to administer twice as much of the potash salt to get equally good results. He holds that mineral waters containing mere traces of lithium can have no special efficacy in gout, and points out that the lithium is present in them as chloride or sulphate, salts which neither directly nor indirectly act as alkalies and possess no solvent action on uric acid (*Year Book of Pharmacy*, 1889).

Mendelsohn has shown the necessity of studying the medium in which uric acid is dissolved (such as blood or urine), because some lithiated remedies (uricedin), whilst not themselves dissolving it, can give that power to the urine. He points out that lithium carbonate is almost insoluble unless given in carbonic acid water: also that if given alone it must become chloride in the stomach, and this being not readily absorbed its combination with uric acid must be limited, and its power of dissolving urates from out the tissues must be very small: any benefit derived from lithia he traced to free diuresis, which was readily induced in animals and men by the acetate and citrate (*Deuts. med. Woch.*, May and Oct., 1895).

Uric Acid Gravel.—Calculus.—When this occurs independently of distinct gouty attacks, lithium salts amply diluted often act well, rendering the “gravel” soluble and the urine clear. According to the observations of G. de Mussy and others, the bromide of lithium exerts a high degree of solvent or lithontriptic power (*Roubaud, Archives Gén.*, 1875).

It has been used with advantage also in Bright's disease, acute and chronic—especially in the former, although in two cases it caused nausea and in one temporary hæmaturia—the diet was not altered (*Lancet*, ii., 1895).

Lithiated injections into the bladder for direct solution of uric concretions were proposed by A. Ure and Aschenbrennen. The former observer ascertained that an oxaluric calculus placed in a 4 gr. warm solution of a lithium salt lost 5 gr. in weight in five hours, but his practical application of this knowledge to the

treatment of calculus within the living bladder has not proved very satisfactory. The patient got some temporary relief from the lithiated injections, and they were presumed to have softened the calculus, but did not reduce its size; lithotrity was performed, but ultimately the man died (Lancet, ii., 1860). Mr. Ure directs attention to the necessity of avoiding lithia when phosphate of sodium is present in the urine, otherwise an insoluble triple phosphate is formed.

Gouty and other Neuroses.—In the forms of irritative or melancholic nervous disorders which sometimes accompany the uric acid diathesis, and in some forms of hysteria, the bromide of lithium promises to be extremely useful. The observers already quoted agree in attributing to it a marked sedative effect on the sensory nerves and upon the spinal cord and reflex sensibility, without much depression of the circulation: its action, in short, is more that of bromine than of lithia.

Epilepsy.—In true epilepsy, bromide of lithium was used by M. Lévy and by Dr. Weir Mitchell. The latter physician found that it was excreted by the skin much like other bromides, but it proved a better hypnotic, and in moderate doses of 10 to 20 gr. relieved or cured epilepsy after larger doses of other bromides had lost their effect (Amer. Quart. Journ., 1870).

Croup and Diphtheria.—Foerster of Dresden has recommended inhalation “of a spray of lithium carbonate solution,” as a solvent of the false membranes in these diseases.

PREPARATIONS AND DOSE.—*Lithii carbonas*: dose, 2 to 5 gr. The diuretic effect is increased by free dilution. *Lithii citras*: dose, 5 to 10 gr. *Lithii citras effervescens*: dose, 60 to 120 gr. *Bromo-citrate of lithium* in an effervescent water containing also potash and soda is prepared. “Granular effervescent citrate,” which is a convenient and portable form, and contains 3 gr. in 2 dr. *Uricedin*: dose, 2 to 8 dr., is a special German preparation, and is a modified citrate. *Thialion* is an American preparation, with salines: dose, 1 teaspoonful in hot water. *Urate and Benzoate of lithium*: dose, 1 to 4 gr. *Hippurate*: dose, 10 to 20 gr. (not official). *Bromide of lithium* (as a nerve sedative): dose, 10 to 20 gr. *Salicylate of lithium*: dose, 20 to 40 gr. *Guaiacate of lithium*: dose, 5 gr. *Glycero-phosphate*: dose, 3 to 8 gr. A lotion should contain 4 or 5 gr. of any soluble salt in each ounce; a vesical injection, 20 or 60 gr. of a soluble lithium salt in 4 oz. of water. *Sulpho-ichthyolate*: dose, 10 to 30 gr. Effervescent tablets of citrate and tartrate, and others of carbonate, and of benzoate with sulphur, and citrate with Vichy salts are prepared.

MAGNESIUM, $\text{Mg} = 24$ (24.18). (*Not official.*)

This metal is not found in a native state, but may be isolated by decomposing its chloride with potassium or sodium. In combination it is widely diffused, a carbonate occurring in magnesite and limestone rocks, a sulphate and chloride in sea-water, in many mineral waters, and in almost all spring-water: a silicate forms talc, meerschäum, etc., and is present in small quantity in all soils, whence it passes (mainly as a phosphate) into plants and animals.

CHARACTERS.—Magnesium is white, lustrous, hard, and very light, its specific gravity being 1.74. It really oxidises, and when ignited burns with intense brilliancy.

COMPOUNDS OF MAGNESIUM.

MAGNESIUM OXIDE—MAGNESIA; MAGNESIA LEVIS—LIGHT MAGNESIA; MAGNESIA PONDEROSA—HEAVY MAGNESIA
($\text{MgO} = 40$).

The two oxides, identical in composition, differ in one of their physical properties, namely their specific gravity: both are "calcined".

CHARACTERS.—Magnesia and light magnesia occur as white powders, almost tasteless; the heavier form is called "magnesia ponderosa" and is smoother than "magnesia levis," and more readily miscible with water. A given weight of the light variety occupies three and a half times the bulk of the same weight of the heavy magnesia. Both forms are almost insoluble in water, but their solubility is increased by heat; they absorb water, and if kept long in it may form a concrete mass of hydrate; they are soluble in acids.

MAGNESII CARBONAS PONDEROSUS—MAGNESIUM HEAVY CARBONATE; MAGNESII CARBONAS LEVIS—LIGHT MAGNESIUM CARBONATE $3(\text{MgCO}_3)$, $\text{Mg}(\text{HO})_2$, $4\text{H}_2\text{O}$.

CHARACTERS.—The carbonates are white powders, soluble in dilute mineral acids with effervescence. The light form appears under the microscope partly amorphous, with slender prisms intermixed. Their solubility in water is slight, but it is much increased by carbonic acid which converts them into bicarbonates.

MAGNESII SULPHAS—MAGNESIUM SULPHATE—EPSOM
SALTS ($\text{MgSO}_4\cdot 7\text{H}_2\text{O} = 246$).

CHARACTERS AND TESTS.—It occurs usually in small acicular opaque or whitish crystals, but may be obtained in large transparent, rhombic prisms. The effervescent salt is in granular form. The pure crystals are somewhat efflorescent, but if they contain chloride of magnesium they are moist or deliquescent. Iron is an occasional impurity and gives a reddish tint to the solution.

The small acicular crystals resemble those of *zinc sulphate*, with which, indeed, they are isomorphous: they may be distinguished (1) by the taste, magnesium sulphate being bitter and nauseous, zinc sulphate astringent; (2) ammonium sulphide gives with magnesium salts no precipitate, but with zinc a white one of sulphide (ZnS); (3) caustic potash gives with magnesium salts a white precipitate insoluble in excess, with zinc a white precipitate soluble in excess. The rhombic prisms resemble those of *oxalic acid*; the latter are markedly acid to the taste. The characteristic test for magnesium salts is the formation of a precipitate of triple phosphate on the addition of ammonia and any soluble phosphate. The precipitate of magnesia which would be produced by adding ammonia in this test is prevented by the previous addition of ammonium chloride in which it is soluble. The usual method of applying the test is to add first ammonium chloride, then ammonia, and lastly sodium phosphate.

ABSORPTION AND ELIMINATION.—Magnesia and its carbonates and neutral salts, such as the citrate and tartrate, are changed partially into chloride in the stomach, and absorbed either wholly or in part according to the amount taken and the condition of the gastric fluids: not more than 15 gr. at a time is changed (Rabuteau); the unabsorbed portion passes on into the intestine, and under the influence of intestinal secretions or of carbonic or other acids, especially in the large intestine, an additional amount becomes absorbed, and any residue passes unchanged with the fæces, or under certain circumstances accumulates in the bowel, and forms concretions. Absorption varies with the degree of acidity of the intestinal tract, and if this be not marked, lemonade or other acidulous drinks will be required to secure solution. When large doses are given the absorbed portion is comparatively small, the remainder absorbs carbonic acid, becomes converted into the bicarbonate of magnesium which is a very indiffusible salt, and acts as a saline purgative. Part of the absorbed magnesia appears in the urine

as a triple phosphate: a certain amount of phosphate is normally in the urine since magnesium is a constituent of the body.

The sulphate of magnesium given in *small* doses is wholly absorbed without producing definite physiological effects. Of large and purgative doses part only is absorbed, and passes out by the urine or other emunctories. Part of the sulphuric acid of the sulphate is withdrawn by potassium and sodium salts met with in the bowel, and the magnesia or its bicarbonate is almost wholly excreted with the motions.

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—Magnesia and magnesium carbonate act as direct antacids and local sedatives; also, when given in the form of powder, as mechanical absorbents. A dose of 30 gr. and upwards given to an adult produces after eight or ten hours moderate semi-solid motions of less than normal odour. It has been stated that the effect of these preparations, though less quickly produced, lasts longer than that of stronger cathartics, and is often more copious, 1 dr. of magnesia causing more evacuation than 1 oz. of Glauber's salt (Trousseau)—also that their effect increases with continuous use, so that sanguineous and mucous stools may occur after some time. On the other hand, if the drug accumulates in the intestine mechanical obstruction may be caused by it, and concretions of ammonio-magnesium phosphate mixed with mucus and débris of food have sometimes formed when large quantities of magnesia or the carbonate of magnesium in solid form have been taken; as much as 2 pints (Gubler) and "several pounds" (Brodie) of such concretions have been found in the colon, and Dr. G. de Mussy required a mallet and chisel to remove one from the rectum (*Med. Times*, ii., 1879). Peritonitis and even perforation have followed from such obstruction, and I have myself seen one fatal case of the kind. The patient was an actor accustomed to hurried, irregular meals, and to consuming large quantities of magnesia (for constipation). On making a *post-mortem* examination, the large intestine was found blocked up by magnesian concretions. (When a moderate degree only of such a condition is suspected, full doses of vinegar deserve a trial.) The citrate of magnesium acts as a mild but efficient and somewhat quicker laxative, and being more soluble than the oxide or carbonate is free from the risk of concretion.

The sulphate in small doses acts as a gastric sedative, and, if not sufficient to purge, often exerts a diuretic effect, especially if the skin be kept cool: 1 to 2 dr. freely diluted, and taken on an empty stomach, will usually produce several watery stools without colic, but with some distension, rumbling and sense of chilliness. The bitter, unpleasant taste, if uncorrected by carminatives, may induce nausea, but this subsides when the purgative effect commences. The pulse and temperature are lowered by the action, and some malaise may be felt from it; more or less subsequent constipation will also be noticed: the biliary secretion is not increased.

Much larger quantities (1 to 2 oz.) are sometimes taken by ignorant or careless persons, and if given to the weakly may cause serious depression amounting to syncope, with or without severe purging (Lancet, i., 1896). Christison refers to a fatal issue from a dose of 2 oz., and 4 oz. taken to procure abortion caused death (Lancet, *ib.*). On the other hand, it has been stated that minute quantities ($1\frac{1}{2}$ gr.), given by hypodermic injection, will induce characteristic serous motions (Luton, Gaz. Hebdom., 1874), but Caville could not verify this result on dogs, and Professor Gubler's trials resulted only in local abscess. More recently, Dr. J. Wood, injecting 2 to 3 gr. of neutral sulphate into the deep muscular layers of the buttock or calf of the leg, reported purgation in about ten hours in 70 per cent. of the cases; others required two such injections, and in about 10 per cent. there was no result. He supposed the intestinal glands to be stimulated, and some of the effused fluid to be re-absorbed, taking the salt again into the blood and lessening the fluidity of the motions, so that constipation followed, as happens sometimes after the drug is given per rectum (Therap. Gazt., 1895). When even large doses are injected into the veins no purgation is caused but rather constipation, or tonic effects (Moreau, Rabuteau).

Poiseuille and also Liebig taught that the purgative action of salines when taken by the mouth was due to osmosis of certain constituents of blood plasma *from* the vessels *into* the intestine, and in support of this view Moreau found that on including a portion of intestine (of an animal) between two ligatures and injecting into it a drachm of Epsom salts dissolved in a little water, afterwards returning the intestine to the abdominal cavity, a large quantity of fluid was poured into the ligatured portion within

twenty-four hours (Archives Gén., 1872). Vulpian corroborated these observations, but noted also general intestinal catarrh, which others have not done (Gaz. Hebdom., May, 1873). Sir Lauder Brunton has recorded results similar to those of Moreau (Pract., vol. xii.). By means of ligatures he made three loops of intestine, and injecting into the middle one a measured quantity of water with a few grains of magnesium sulphate, and into the others the same amount of water only, found after a few hours that the middle one contained treble the quantity of fluid injected, whilst the others were empty. He experimented also with *concentrated* solutions passed into the middle loop, always with similar result, and suggests that it is produced by a *direct stimulation* of the intestinal mucous membrane. Rutherford and Vignal also considered the drug a pure stimulant to the same membrane; this view has been supported by the experiments of Dr. Matthew Hay (Journ. of Anat. and Physiol., vol. xvi., 1881-2). Aubert and also Sir Lauder Brunton showed that the osmotic theory was not tenable, arguing from the endosmotic equivalent of the various salts and from the structure of the intestine, and Dr. Hay regards the increased secretion as a true *succus entericus*, such as was obtained by Moreau after the division of the nerves of the intestine. The increase of fluid is partially due to diminished absorption, and whatever strength of solution is introduced, the amount of fluid poured out is such as to form a solution of 5 to 6 per cent., and then it is slowly absorbed (from the looped intestine). There is a corresponding withdrawal of liquid from the blood, which is replaced by abstraction from the tissues (Hay).

Some eminent writers, chiefly German, have offered other explanations which require a brief notice. Radziejewski observed in experiments on animals that the fæces were quite liquid when passing from the small to the large intestine, and argued that saline purgatives simply hurried them through in this liquid state, and that the larger quantity of fluid in stools procured by purgatives could not come from the blood, or even the glands, because on analysis the proportion of albumin in them was found too little for such a source (Reichert's Archiv, 1870, 39, 77). Thiry, experimenting with the peculiar form of intestinal fistula devised by himself, and formed by a separated portion of bowel communicating with the external surface of the abdomen, found that although

local irritation would excite secretion in it, saline purgatives such as sodium sulphate would not do so, and concluded with Radziejewski that they simply *increased peristalsis*. Buchheim taught that besides this, on account of their low diffusion-power, they did not readily pass through the intestinal membrane, but remaining in the canal retained the water in which they were given and also much of the natural watery secretion from the liver, pancreas and glands (a very large quantity, according to Kühne), and so carried from the intestine a large quantity of fluid without necessarily drawing it from the blood by endosmosis, or from the glands by stimulation. These reasonings, although ingenious, seem to me answered or qualified by the later experiments of Moreau and of Brunton. Thiry's fistula disarranges normal structure too much to furnish a strong basis for hypothesis, whilst Legros and Onimus have produced satisfactory evidence that peristalsis *per se* is but little increased by sulphate of magnesium (Journ. d'Anat., 1869).

Urinary System.—Magnesia has sometimes caused the solution of uric acid deposits when alkalies have failed to do so, and Mr. Brande pointed out that it could render the urine alkaline more permanently, if more slowly, than potash or soda. Thus 2 dr. of soda gave a maximum of alkalinity in a quarter of an hour, 1 dr. of magnesia only at the end of six hours, and $\frac{1}{2}$ dr. in twelve hours (Philos. Trans., 1810). A deposit of triple phosphate occurred, but since earthy salts can be passed in only limited quantities in the urine it is of interest to know precisely how magnesia renders the secretion alkaline. Caulet concluded from recent researches that both it and lime do so only *indirectly* through the digestive organs—*i.e.*, they neutralise a part of the acid of the gastric juice, and consequently more soda is excreted with the urine and becomes the direct agent in determining its alkalinity. In support of this he finds on analysis no increase in the amount of earthy salts in the urine (rendered alkaline under administration of magnesia), but marked excess of soda (Bull. de Thérap., 1878). In further support of this observation, we have the fact that during normal digestion, when the acid of the gastric juice is being neutralised and withdrawn from the system, the acidity of the urine becomes less, and in some disorders of the stomach is even replaced by alkalinity.

Glandular System.—Some observers have attributed to magnesia an alterative action, and Grange, Bouchardat and others state that its habitual use, as in drinking water, will cause goitre. Some support is given to this idea by the fact that enlargement of the thyroid gland in mice has followed after mixing magnesia with their food (Gubler), but on the other hand many waters from goitrous districts have been analysed without finding in them a trace of magnesia (*Med.-Chir. Rev.*, i., 1862). The latest conclusions are that the presence of magnesia in drinking water is not of much importance (*Lancet*, ii., 1891).

Toxic Action.—Jolyet and Cahours reported magnesium sulphate to be the most toxic of neutral purgative salts, 30 to 90 gr. having caused sudden death in dogs when injected into the veins. Vulpian noted abolition of voluntary and reflex movements in a frog poisoned by the salt, and its effect has been compared to that of curare (*Archives de Physiol.*, 1869). Binet distinguished it from this by the late onset of respiratory arrest, but he also reported paralysis of peripheral nerves and ultimate heart stoppage in diastole (*Rev. Méd.*, Geneva, 1892). Dr. M. Hay found that in cats and other animals doses of 5 gr. per pound of body weight, when injected into the veins, produced death by paralysing the heart and the respiration. When administered by the mouth in such animals, the difference between absorption and excretion is not sufficiently great to allow magnesium salts to accumulate in the blood and so produce toxic effects.

SYNERGISTS.—Absorbent substances such as charcoal and black oxide of manganese aid the mechanical effect of magnesia in powder. Its purgative effects are aided by acids, by the sulphate and citrate of magnesium, and other neutral salts. It is usual to combine the sulphate and carbonate in a mixture, but unless care be exercised they are liable to form lumps which are not readily soluble. The analogues of sulphate of magnesium are the sulphates, phosphates, tartrates, sulphovinates of potassium and sodium, and the chloride of magnesium. Water, cold and refrigerants generally are other adjuvants of its action. Dr. Laycock found quinine aid the purgative effect of magnesium sulphate, 1 gr. of quinine with only 1 scruple of the salt given every three or four hours acting as well as much larger doses given without the tonic; he supposed this to depend upon improvement of nervous power (*Med. Times*, i., 1863).

ANTAGONISTS AND INCOMPATIBLES.—Acids given with magnesia destroy its absorbent, but increase its purgative powers; on the other hand, alkalies antagonise its purgative effects. Alcohol, aromatics, and opium lessen its anti-febrile and depletory effects. With regard to opium, Buchheim and Wagner observed that if it be brought in contact with the mucous membrane before the sulphate, no increased flow of liquid occurs, but liquid is absorbed from the membrane: they concluded that opium favoured the absorption of the salt, but in my opinion it acts by paralysing the terminations of the nerves and thus dulling the sense of irritation.

Magnesia forms a rather insoluble salt with arsenious acid, and is ordered in the German Pharmacopœia as part of the official “*antidotum arsenici*.” Schroff proved magnesia to possess antidotal powers in cases of poisoning by arsenic and cobalt, if given early (*Med.-Chir. Rev.*, 1859). Sugar and magnesia mixed together have been found useful in such cases (*Lancet*, ii., 1873). Orfila proposed it as an antidote to phosphorus, and there is some but not exclusive evidence in its favour (*Med.-Chir. Rev.*, 1857). It has seemed of use in carbolic acid poisoning.

THERAPEUTICAL ACTION.—*External.*—Magnesia being smooth, light, non-irritant and antacid, makes a good absorbent dusting powder. It has been used for erythema, erysipelas and similar inflammatory conditions of the skin, and also for atonic ulcers, exposed surfaces and inflamed wounds. Talc, a foliaceous silicate, is perhaps its best form. French chalk is a harder silicate, but still smooth and soft to the skin. A paste made with calcined magnesia and water spread in a thick layer left to dry on the skin has been found very useful in burns of the first and second degree—pain ceases on application, fresh paste is added when any dries off, and the wound heals under it without pigmentation (*Prof. Vergeley, Bordeaux*). On the strength of some cases of diphtheria successfully treated by local insufflations and internal administration of the sulphite, it was recommended with enthusiasm, but further observation seems to reduce its power to the equivalent of boracic glycerin—it must be reckoned, however, as a useful form of sulphurous acid (*q. v.*) and very suitable for some cases (*Martin and others, Lancet*, i., 1895).

THERAPEUTICAL ACTION.—*Internal.*—**Dyspepsia.**—In acidity, pyrosis, and allied symptoms of irritative dyspepsia such as heartburn, flatulence, colic or constipation, magnesia and its carbonate are very useful, and their efficacy may be increased by the addition of bismuth or of carminatives: such symptoms are often brought on by food containing too much fat, and this point should be attended to. Headache accompanied with nausea and mental depression often occurs in the conditions described, and may be relieved by magnesia. When vomiting is a troublesome symptom in the dyspepsia either of children or adults, and in the vomiting of pregnancy, magnesia often acts well. An effervescent solution of the carbonate or citrate is a good form, but 5 to 10 gr. doses of the sulphate will sometimes act better. I have known this succeed in the vomiting of albuminuria and in cases where hepatic derangement was more marked than acidity.

Acidity and Diarrhœa of Children.—The mild antacid and laxative action of magnesia and its slight taste render it a very suitable remedy for the acidity of the stomach which so readily occurs in children; it is valuable both when constipation is present, and when unwholesome food has caused irritative diarrhœa marked by a red furred tongue and greenish, sour and liquid motions: 2 to 10 gr. of the carbonate may be given thrice daily, its antacid action only being desired and its purgative effect avoided, unless with the first dose. On several occasions I have known 4 gr. severely purge an infant at the breast. When the attack is clearly traceable to unsuitable food, "Gregory's powder," containing rhubarb and ginger with the magnesia, is a popular and useful combination.

Constipation.—In the constipation of delicate persons, especially of pregnant women, also of those subject to gout or rheumatism, hæmorrhoids, or other rectal affections, magnesia is a valuable mild laxative; if required frequently it should be taken in solution (fluid magnesia) and with lemon-juice if the system be free from acidity. Dr. Cheadle has written to advocate the use of magnesian salts continuously for some time rather than intermittently in the constipation of infants (*Lancet*, 1886), and of adults, for whom he adds strychnine, acids, etc. (*Lectures*, 1900). The citrate or the sulphate are useful aperients at the commencement of a febrile attack of almost any kind, their action being

rapid and more or less depletory; the former may be given effervescing in mild cases, but when a full and decided effect is desired, 1 or 2 dr. or more of the sulphate should be used, this also may be given in effervescent form or in lemonade or acid infusion of roses, but general experience has proved that it acts best with tincture and infusion of senna, cascara, etc. In habitual constipation $\frac{1}{2}$ to 1 dr. given in a glass of lemonade or aromatic water in the early morning will often answer every purpose.¹ Dr. Fleming found the addition of small quantities of atropine advantageous (B. M. J., ii., 1865).

It is more usual now, and I believe better, to make use of the magnesium salts in *combination* with others as they are found in many natural mineral waters, such as Seidlitz, Apenta, Æsculap, Friedrichshall, or Hunyadi Janos, or the stronger Rubinat, half a glass or a glass of such waters being ordered with warm water in the early morning.² To obviate constipation and headache during the use of astringent tonics, moderate doses of the sulphate may be usefully added to medicines containing sulphate of quinine, iron, acids, etc.

Obstruction.—In cases of intestinal obstruction dependent upon hardened fæces, full doses of the sulphate freely diluted and given every four hours often succeed well; sometimes the action may be favourably assisted by belladonna. Dr. Strahan has recorded their value in obstruction and colic caused by iron.

Plumbism.—In cases of colic and constipation dependent upon lead poisoning, sulphate of magnesium is a valuable agent; it should be used in conjunction with iodide of potassium, and Sir Lauder Brunton has well shown that if the latter remedy removes from the tissues the metal in soluble combination yet it is readily reabsorbed unless the bowels be freely and regularly moved (Pract., vol. xii.): $\frac{1}{2}$ oz. doses may be required. Dr. Copland and others used the sulphate with sulphuric acid before the special value of the iodide was known.

¹ From remarks under the physiological action, it will be gathered that the purgative effect varies with the amount of dilution, and a concentrated solution may act as a strong hydragogue cathartic.

² It was from the Epsom springs that the first described magnesium salt—sulphate—was obtained in 1695.

Jaundice.—Although the sulphate has no specific cholagogue action, it is a very suitable aperient in cases of catarrhal jaundice. Dr. Budd recommends it in combination with the carbonate and aromatics, but I generally prefer one of the mineral waters before mentioned.

Diarrhœa.—In intestinal irritation and diarrhœa dependent upon unwholesome food, and especially stone-fruit, sulphate of magnesium is a good evacuant, because it produces so little irritation. In cases of severe dysenteric diarrhœa from this cause I have often given drachm doses at intervals of six hours, for three or four doses, with the best results. Similar treatment has recently been again advocated with illustrative cases of cure from "large doses." Dr. Bradbury finds they cause less griping than small ones owing to more copious discharge of fluid with less affection of the muscular coat (New York Med. Record, 1892).

Enteritis.—Dysentery.—Dr. H. Wood speaks of the sulphate of magnesium as the best aperient in enteritis and colitis when one is required (usually treatment by opium is to be preferred). In true dysentery there is much evidence as to the value of the same salt, although it is not generally known. The original prescription of it seems to be in Heberden's Commentaries, 1803. Trousseau called attention to it in 1826 (*Archives Gén.*, v. xiv.), Giacomini recognised it (*Treatise on Mat. Med.*), and Stillé confirmed their observations; he gave about 60 gr. freely diluted every two hours, with the result of at once diminishing tenesmus and bloody discharges and inducing watery feculent stools; the treatment should be commenced early, and is best suited for sthenic cases; an occasional opiate at night may be given during it. That the same method is equally available for chronic and debilitated cases is shown by the experience of Mr. Ford in Melbourne, where dysentery was for a long time epidemic and more severe in character than he had ever seen it in this country. Some of his patients (medical men and others) had suffered for many months with only temporary relief from chalk mixture, laudanum, etc., when he gave them drachm doses of the sulphate with 20 min. of sulphuric acid every four hours, and a blue pill with opium (1 gr.) at night; mustard was applied over the abdomen and farinaceous diet ordered. In the course of twenty-four to thirty-six hours the dejections became feculent with

less blood, and in about nine days all irritation had usually subsided. Mr. Ford adopted this method on the hypothesis that excessive action prevailed in one part of the intestine (the colon), while the rest of it was inactive; and he hoped to "restore unity of action," and also to "eliminate morbid material." However this may be, he is able to report that, in seven years of extensive practice, he did not lose one case of dysentery in the adult (Australian Journ. and Ranking's Abst., 1859). This treatment was adopted by Dr. Leahy in ninety-five cases of acute dysentery with only two deaths—he gave 1 dr. of a saturated solution with acid every hour or two till normal stools were passed—then opium or astringents (Lancet, ii., 1890). Since this date further favourable evidence has accumulated. Dr. Wyatt, recording success in acute tropical uses after failure of ipecacuanha, gives a striking case almost moribund under opium, recovering under sulphate, and dying when opium was substituted (B. M. J., i., 1899). Ch. Johnston and others corroborate, some praising it also in chronic cases, others not: it was presumed to promote a flow of bile and to deplete the intestine (*ib.*). Rouget at Port Louis was able by this method to reduce the mortality in acute cases from 8 per cent. to nil, and Jervis had extremely good results in India (*ib.*, ii., 1899): additional evidence is in B. M. J., i., 1900. After the acute stage antiseptics or astringents or both are admissible. (The sodium sulphate is more commonly used in France, and it is said with equal success.)

Peritonitis.—Similar treatment, *viz.*, by saline purgatives—of which magnesia is one of the chief—has been by some advocated in this disorder, and there is clinical evidence that in *commencing* peritonitis after laparotomy this treatment is good, if not the best (B. M. J., i., 1886; ii., 1892). It is not so clear that the same treatment is safe in the *developed* malady, especially when independent of surgical cause, but Dr. Baldy claims that by active peristaltic action adhesions are prevented, products of inflammation drained away, and inflamed surfaces relieved of engorgement, whilst pain and pyrexia are lessened: if relief be not given, he concludes that surgical interference will be required (Philad. Med. News, Dec., 1888). At present the more accepted treatment is by opium, rest, etc., but the question of aperients must be carefully considered at every point of the case.

Appendicitis, etc.—In 1902 Mr. Marmaduke Sheild advocated the direct introduction of magnesium sulphate into the cæcum, in cases of operation for perforating appendicitis associated with septic peritonitis, and paralytic distension of the intestines. He employs from 2 to 4 dr. of the salt in solution, with 2 dr. of glycerine and 5 to 10 min. of the tincture of *nux vomica*. The solution is readily introduced through the stump of the appendix previous to ligature. In about two hours a turpentine or glycerine enema is given, and the result in several desperate cases has been an “explosion” of gas and fœculent matter by the rectum and rapid amelioration of the serious abdominal distension. The method is one deserving of trial by surgeons in these dangerous cases.

Hæmorrhage.—Sulphate of magnesium is a valuable adjunct to astringent remedies for hæmorrhage, because it helps to lessen arterial tension and capillary congestion at the same time that it obviates constipation. In *menorrhagia* it may be given with sulphuric acid; in *hæmoptysis*, with ergot, acid and digitalis; and in *hæmatemesis*, with alum and opium.

Dysmenorrhœa.—In delayed and obstructed menstruation, when the discharge is scanty, dark and of glutinous character, I have long prescribed the carbonate of magnesium with beneficial results, and especially when the irregularity is attended with sick headache and mental depression; it is most indicated in rheumatic subjects. Five to sixty or ninety grains may be given according as to whether the constitutional, the laxative, or fully purgative action is required. The small dose should be given each night for the first fortnight after the cessation of the menses, and the larger doses during the latter fortnight, or especially before or during the period, or when headache and depression are present.

Lithiasis.—Uric Acid Diathesis.—The power of magnesia to dissolve uric acid and to lessen its formation, whether directly or indirectly, has already been mentioned. Amongst other instances Mr. Brande records that of a man aged sixty, accustomed to pass much uric acid and even calculi, and who had taken daily either 9 dr. of “subcarbonate” of sodium, or 3 dr. of that of potassium for more than a year without good effect, yet under the use of 60 gr. of magnesia thrice a day the acid soon diminished in amount, and after three weeks of continuous treatment it seldom recurred. Since Mr. Brande’s memoir (1810) the remedy has been often used

in similar cases. Sir Benjamin Brodie combined 6 gr. of magnesia with 12 gr. of potassium bicarbonate and 15 gr. of bitartrate, and found that it often acted well. A boro-citrate of magnesium, made by dissolving the borate in citric acid, has been recommended by Köhler for similar conditions (Med. Times, 1879), though I have found it still more useful in phosphaturia. It is also used to sterilise the urine before operations, etc. (Lancet, i., 1898).

Chronic Gout.—Magnesia in combination with magnesium sulphate, and sometimes with colchicum in addition, was largely used by Sir Charles Scudamore, and with satisfactory result. It is especially adapted for the gastric derangements to which gouty patients are liable. In rheumatism its value is not so evident.

Serous Effusions.—Dr. Matthew Hay advocates large doses of the sulphate—one or two ounces—for pleural and other effusions, the taking of fluids by the mouth being much limited during the treatment.

Irritant Poisoning.—As already mentioned, magnesium oxide and carbonate form nearly insoluble compounds with arsenic and cobalt, and, besides being used as antidotes to those poisons, they have been given with more or less success in cases of poisoning by corrosive sublimate, mercurial oxide, and salts of copper. They are perhaps best suited for neutralising the action of strong acids, whether mineral or vegetable, and act well when mixed with charcoal. When used for *oxalic* acid poisoning, large quantities must be given to form a basic insoluble salt (Husemann). In the case of a lady, where nearly a tablespoonful of *carbolic* acid was given and unconsciousness came on in twenty minutes, three ounces of sulphate of magnesium were given with the albumin of three eggs, and the patient recovered after vomiting; the bowels were moved only once (Pract., i., 1888). In cases of *carbolic* acid poisoning it is a good plan to wash out the stomach with a solution of sulphate of magnesium in tepid water until the smell of the acid is no longer perceived; the stomach should be left full of the solution (Murrell).

PREPARATIONS AND DOSE.—*Magnesia ponderosa*—*magnesia levis*: dose, as an antacid, 10 to 20 gr.; as a purgative or adjunct, 30 to 60 gr. or more—4 to 8 gr. will purge an infant at the breast; children of about ten years require 30 to 40 gr. The *pulvis rhei compositus* (Gregory's powder) contains 6 parts with every 2 of rhubarb and 1 of ginger. *Magnesiæ carbonas*

ponderosus—magnesiæ carbonas levis: dose, 10 to 60 gr.; 10 to 20 gr. as antacid, 20 to 60 gr. or more as a purgative. *Liquor magnesiæ carbonatis* (fluid magnesia) contains 10 gr. of the official carbonate in the ounce, or about 2 per cent.: dose, 1 to 2 fl. oz. The bismuth lozenges, B. P., contain about 2 gr. of the carbonate of magnesium. *Liquor magnesiæ citratis* (not official), the "limonade purgative" of the French codex, may be taken in doses of 5 to 10 fl. oz. A "granular effervescent citrate of magnesia" is in popular demand, but was proved at a trial under the Adulteration Act to be in reality a citro-tartrate of sodium (Pharm. Journ., 1873). I believe that an article containing at least some citrate of magnesium is now supplied. The *acetate* of magnesium is said to have several advantages of solubility, etc. (Record, 1884). *Magnesiæ sulphas*: dose, 10 to 20 gr. for irritable conditions of the stomach, or in combination with astringents or tonics; when given with senna or other purgatives, dose 30 to 60 or 120 gr., according to the frequency of repetition. For diuretic effects 20 to 60 gr.; as a purgative in a single dose 2 dr. to $\frac{1}{2}$ oz., more or less diluted. *Magnesiæ sulphas effervescens*: dose, 60 to 240 gr., for repeated administration; for a simple dose, $\frac{1}{2}$ to 1 oz. Coffee and infusions containing tannin disguise the nauseous taste. Of the effervescent form 1 to 4 dr. for repeated doses, 1 oz. for a single administration. A *double sulphate of iron and magnesia* (not official) forms a crystalline greenish-white powder, soluble in water and stable without marked astringent or aperient properties (B. M. J., i., 1891). The *mistura sennæ composita* contains 2 dr. in each fluid ounce combined with senna and aromatics. Other preparations are a citrate; a boro-citrate, in white soluble powder or scale (not official), dose, 15 to 30 gr.; a borate; a soluble white-amorphous glycono-phosphate, dose, 3 to 10 gr.; a gynocardate (B. M. J., ii., 1892); a ricinoleate (P. J., 1895); a salicylate in soluble colourless needles, and a sulphite in white crystalline powder, dose, 10 to 30 gr., soluble in water, insoluble in rectified spirit (*v.* Sulphurous Acid).

MANGANESE—MANGANESE, Mn = 55 (54·52). (*Not official.*)

Manganese is found in many ores, and generally associated with iron; the most common one is the black oxide, or peroxide (pyrolusite), which is found abundantly in Great Britain and in various parts of Europe.

CHARACTERS.—Manganese is a greyish-white metal, hard and brittle, of specific gravity 8. It emits a peculiar odour in a moist atmosphere, or if handled. When pure it oxidises readily in the air, and hence is kept under naphtha, or in sealed glass tubes; it is dissolved by dilute sulphuric acid.

COMPOUNDS OF MANGANESE.

MANGANESII OXIDUM NIGRUM—BLACK OXIDE OF MANGANESE ($\text{MnO}_2 = 87$). (*Appendix*.)

CHARACTERS, ETC.—The peroxide of manganese is a black heavy powder free from odour and taste. It is insoluble in water, but dissolves in hydrochloric acid with the evolution of chlorine.

Manganesii Oxidum Præparatum vel precipitatum (not official).—The prepared oxide is obtained by digesting the powdered black oxide in dilute hydrochloric acid for twenty-four hours, then levigating and drying.

MANGANESII SULPHAS—SULPHATE OF MANGANESE ($\text{MnSO}_4\text{H}_2\text{O} = 223$). (*Not official*.)

CHARACTERS.—It occurs in colourless, or pale rose-coloured, transparent crystals, freely soluble in water.

The *sulphate*, the *double sulphate*, the *double carbonate* and the *double iodide with iron* are sometimes prescribed; less frequently such compounds as the *lactate*, *phosphate*, *hypophosphite*, *citrate*, and *valerianate of manganese*. The *citrate* is a crystalline body and is a valuable salt.

Permanganate of Potassium (v. p. 786). There are similar compounds with calcium, sodium and zinc.

ABSORPTION AND ELIMINATION.—Kobert found that manganese salts given by the mouth were not absorbed, and argued that no elimination could take place in the urine or otherwise. His observations were probably erroneous. When injected subcutaneously, manganese is eliminated from the blood into the stomach and bowel, and by the kidneys (*Archiv f. expt. Path.*, xvi., 1883). Cahn came to the same conclusions (*ib.*, xviii., 1884), and the same has been said of permanganate on the supposition of its reduction to hydroxide in the stomach. Sir William Turner found evidences of manganese in the urine of a diabetic patient who had taken potassium permanganate for three weeks, showing that that salt was absorbed, and eliminated by the kidneys (*Edin. Med. Journ.*, 1861). Traces have been found in the urine of man, and more than traces in the urine of herbivora; these are derived from vegetable food, hence there must be some absorption (*Ber. d. deutsch. chem. Gesellsch.*, xiv., 1881), and therapeutical effects confirm this.

PHYSIOLOGICAL ACTION. — *Internal.* — **Circulatory System.**—The presence of manganese as an essential element of the corpuscles has been relied upon as a guide to its action, but it seems to be rather an accidental than a normal constituent of the blood. Wurzer, in 1830, first announced its presence, and Millon, Hannon and Burin-Dubuisson corroborated this, whilst Melsens, Bonnewyn and others could find no manganese on repeated analysis; Melsens operated on 7 kilogrammes of blood from twenty-one different persons. M. Glénard analysed in various ways blood from forty subjects of varying age and sex, and found the metal in one case only. He concluded "that manganese is not an essential element of human blood; it may be found accidentally, but only in minute amount; it does not enter by the lungs or skin, as proved in the case of miners" (*Gaz. Méd. de Lyon*, 1854). M. Riche, has detected minute quantities in the blood of bullocks, etc., and a trace in human blood (*Bull. Acad. de Méd.*, 1877). Manganese in certain of its chemical properties resembles iron, and that it has a similar therapeutical action has been often stated, but must be considered problematical.

According to Laschkewitz, the organic salts of manganese in moderate doses (subcutaneously) slow the pulse and the heart-action, and cause lowering of blood-pressure and paralysis of muscles and nerves, which iron, he says, certainly does not; after death from manganese poisoning the heart is found dilated, and does not respond to electrical stimulation (*Cbl. f. med. Wiss.*, 1866). This may be the case in laboratory experiments, but in at least one case of acute poisoning (thirty-five minutes) from a large dose of permanganate taken in beer the heart was arrested in systole (*Lancet*, ii., 1899). Kobert finds that the intravenous injection of manganese salts first transiently stimulates the vaso-motor centre, then paralyses it; later the heart itself is depressed and finally paralysed; the cardiac nervous centres suffer first and later the muscle.

Nervous System.—Certain nervous phenomena are determined by manganese salts. Toxic doses cause death with convulsions, and $\frac{1}{2}$ to 1 gramme injected into the veins of rabbits or dogs produces cramp and death from heart-palsy, or else faintness and weakness and slower death with fatty degeneration (*Lasch-*

kewitz). The pupils are dilated, the temperature unaffected. Rabuteau injected a little more than 1 gramme into a vein of a bitch, and at first there were no symptoms, but on the following day tetanic convulsions set in with trismus and opisthotonos, and death followed shortly: the white substance of the spinal cord was shrunken, the grey matter congested. Kobert states that rabbits after large doses subcutaneously die in epileptiform convulsions; after non-lethal doses they suffer from diarrhœa, loss of appetite, and great depression of the function of the spinal cord, the transverse conducting power being destroyed though the longitudinal conduction remains intact (*loc. cit.*). In dogs excessive vomiting and great nervous depression are seen after hypodermic injection; there are no convulsions, but jaundice and renal inflammation are striking symptoms always present. It must be remembered that rabbits cannot vomit, hence the difference in symptoms.

Large doses given for a long period induce effects analogous to those of zinc—progressive wasting and feebleness, a staggering gait, and paraplegia. Kobert states that chronic poisoning can only be induced if the salt is administered by subcutaneous or intravenous injection. Cases of chronic poisoning observed in man have been reported by Couper in workers in manganese. The symptoms were muscular wasting and paralysis, which may have been due to other metallic admixtures (*Brit. Annals of Med.*, 1837).

Digestive System.—The saccharated carbonate of manganese has no peculiar taste, the sulphate is styptic, metallic and disagreeable. Small doses (5 to 10 gr.) of these salts promote appetite and digestion, but larger quantities (1 to 2 dr.) are apt to irritate and cause vomiting and purging. Severe toxic symptoms—mainly gastric—were produced by 2 gr. pills of permanganate taken several times daily to the amount of 22 gr. (*Lancet*, ii., 1899). The oxide, which is gritty on the tongue, exerts a sedative action on the gastric mucous membrane.

The sulphate has been credited with the power of stimulating the secretion of bile since the observations of C. G. Gmelin, who found in animals poisoned by large doses inflammation of the stomach and intestines, and “so large an amount of bile poured out that the whole tract was coloured like yellow wax.” He reported a less degree of the same effect in man, and Ure found

that 60 to 120 gr. acted as a cholagogue purgative. Dr. Goolden took various doses, from 1 up to 30 gr., before vomiting occurred, but states that as a rule 10 to 20 gr. will cause nausea and purging with a copious secretion of bile (Lancet, 1840, and i., 1878). Dr. Rutherford, however, failed to corroborate this experience, at least in animals, for after giving 60 gr. to a dog, the biliary secretion was at once lessened, and severe diarrhœa occurred. After death the mucous membrane of the small intestine was found pulpy, "as if the epithelium had been dissolved by caustic." In another dog a dose of 20 gr. caused lessening of bile, although benzoate of sodium given afterwards stimulated its secretion. Rutherford concludes that the drug is a powerful intestinal, but not an hepatic stimulant, acting very like sulphate of magnesium (B. M. J., i., 1879). Nitrogenous excretion is increased by it. Poisonous doses induce acute fatty degeneration of the liver, like phosphorus. Abortion has occurred after taking permanganate (Therap. Gaz., 1887).

SYNERGISTS.—Iron may be considered as allied in action to manganese within the limits of the preceding observations; the two substances are constantly associated in nature. Copper, silver, and zinc have allied effects on the nervous system. Goolden speaks of sulphate of manganese as substitutive for mercury as regards the action on the liver, but this is doubtful. Luchsinger and others associate molybdenum and tungsten with manganese, asserting that all three produce paralysis in frogs, and inflammation of the digestive tract in warm-blooded animals (Rev. Gén., xxiii., 1884).

ANTAGONISTS AND INCOMPATIBLES.—Caustic alkalies and salts of lead, silver, and mercury are *chemically* (not therapeutically) incompatible with manganese, and the potassium permanganate has been used as an antidote to phosphorus, opium, muscarine, strychnine, colchicum, savin, oxalic acid, and cyanides, and acts probably by oxidising—but this antidotal action cannot be depended on except in the case of opium and calabar-bean and their alkaloids. Tannic acid and vegetable astringents are not incompatible, as they are with iron; manganese compounds are decomposed on contact with organic substances, *e.g.*, cork.

THERAPEUTICAL ACTION.—*External.*—**Hæmorrhage, etc.**—The chloride of manganese and iron has been used by

M. Pétrequin, in preference to the simple perchloride of iron, as a local hæmostatic; in Italy it has been applied to necrosed bone, and injected into fistulous tracts and hydroceles (Pract., vol. v.), but it has no advantage over other remedies.

Skin Disease, etc.—The same remark applies to the use of an ointment made with the oxide of manganese (3ij to 3j of lard), which has been recommended in *scabies* and *ringworm*, and, combined with sulphur, in *prurigo*. The potassium permanganate treatment for chronic local patches of eczema is sometimes indicated (Beissel of Aachen); after removal of crusts the reddened surface is dried and painted with 1 in 10 solution in water, once or twice daily till a black adherent covering forms, and this is left on for six to seven days before separating. The application is painful at the time, but I have found it effective: it is suitable only for covered parts. A weaker solution is used as a lotion for ulcerations and suppurating wounds, and as injection in leucorrhœa, ozæna, empyema, gonorrhœa, etc., for which the zinc permanganate is specially good, whilst the calcium compound is best as a wash or spray in stomatitis or diphtheria. The pink or green colours rapidly change to brown on contact with discharges, which may be considered disinfected when the injections return unchanged. Brown stains may be removed by sulphates or oxalic acid in solution.

Snake Poisoning.—Wynter Blyth showed that admixture of potassium permanganate with venom rendered it inert, and Lacerda reported that intravenous injection of a 1 per cent. solution, soon after one of snake poison, proved antidotal in dogs (October, 1881). Dr. Vincent Richards found that if the salt be injected into the puncture sufficiently soon, ill-effects are prevented (Indian Med. Gaz., 1882). Twenty minims of a 2 per cent. solution freshly prepared should be injected under the skin in two or more places, and especially into the orifice made by the fangs, for it is essential that it should come into actual contact with the poison. It must be remembered that this is a chemical, not a physiological antidote: its efficacy is still doubtful.

Opium Poisoning.—The value of permanganates in this condition, suggested by Dr. B. Smith in 1884, has been amply demonstrated by Dr. W. Moore, Dr. Luff and others (B. M. J., i., 1895-96, etc.). The former took 5 gr. of morphia sulphate in

1 oz. of water, and a few seconds afterwards 8 gr. of potash permanganate in 8 oz. of water, and found no narcotic effects whatever. A case where 16 gr. was taken recovered after three doses of 5 gr. each of the antidote—and Dr. Luff by analysis of vomit mixed with known quantities of both drugs proved the morphia was no longer detectable. He advised a proportion of 6 gr. of antidote for each ounce of laudanum taken (if known), or, if unknown, 8 to 10 gr. in 4 to 8 oz. of water, and that the stomach should be washed out with a weaker solution two or three times, at intervals of half an hour. When swallowing was difficult, Dr. Moore gave the remedy by nasal tube or by hypodermic injection with some advantage.

Disinfectant.—Free chlorine is readily and cheaply generated by acting on peroxide of manganese with hydrochloric acid, or by heating a mixture of common salt and peroxide with sulphuric acid and water (equal parts). The former process is recommended in the Swedish Pharmacopœia, 1 part of peroxide (pyrolusite) and 4 of acid being ordered; the latter process is that known by the name of Guyton Morveau: a mixture of manganese oxide $7\frac{1}{2}$ grammes, and 10 grammes of salt, with sulphuric acid and water, of each 20 parts, will disinfect a space of 30 cubic metres. The official solution of permanganate is 1 per cent.; a saturated solution is 5 per cent., and when diluted 500 times is suitable for lotions, disinfection of hands, and of stools in typhoid, and drains, etc. It disintegrates foetid and decomposing organic substances and destroys bacteria, but it is not now so much used as carbolic acid, etc.

THERAPEUTICAL ACTION. — *Internal.* — **Anæmia.** — **Chlorosis.**—Manganese was introduced into practice by M. Hannon, of Brussels, with special reference to the treatment of these conditions. He argued that during digestion sulphuretted hydrogen is formed, and reacts on the ferrous and man-ganic compounds contained in the intestine, changing them into insoluble sulphides, and thus removing essential elements of hæmoglobin. This happens especially (he supposes) in chlorosis, and the remedy is to supply more of a metal which can form such sulphides, and prevent the removal of essential elements of the organism. Hence, bismuth, lead and copper are said to prove as serviceable as iron or manganese, though the latter are

better assimilated (*Presse Médicale Belge*, 1850, and Guibert). M. Hannon goes even farther than this, and describes three forms of chlorosis, according as there is a deficiency in the blood of iron only, of manganese only, or of both metals. His statements are largely theoretical, and apart from the fact that even the necessary presence of manganese in the blood of healthy persons is doubtful, an appeal to clinical results does not bear out the suggestion of its great importance as a hæmatinic remedy, but rather the contrary. He himself and later Professor Rükle, of Bonn, who supported his views on chlorosis, reported very good effects from it, as also did Dr. Steer in chlorotic anæmia, traumatic anæmia, phthisis, and the anæmia of children; but he used saccharated carbonate of manganese with iron, not manganese alone. Dr. Menke wrote (1857) on the importance of manganese as an ingredient in the Pyrmont waters—but in the usual analyses it is not even named. Sir J. Simpson found the phosphate sometimes useful in amenorrhœa, given either with or without iron, but says very little about it (*Med. Times*, i., 1861). The observations of Sir A. Garrod, who failed to cure every case of anæmia in which he used manganese alone, whilst the same cases rapidly improved under iron—have been repeated on a larger scale by Dr. Ralph Stockman (*B. M. J.*, i., 1893). It is true that M. Pétrequin was an enthusiastic advocate for the remedy in all forms of impaired blood-condition, and also in intermittent fever, phthisis and cancer, but the general experience of the profession is not with him or M. Hannon. It may be stated without much hesitation that the use of manganese in the treatment of anæmia is almost abandoned.

Amenorrhœa, etc.—Drs. Ringer and Murrell first brought the potassium permanganate into prominent notice as a remedy for this condition, and there is no doubt that the good effect is due to the manganese, not to the potassium; they recommend 1 to 2 gr. three or four times daily for a few days before the expected period. The drug should be given in tabloid (dissolved) or in a pill made up with kaolin or vaseline (a vegetable extract forms an explosive compound), immediately after meals, and each dose should be followed by a draught of fluid. If these precautions are not followed, the drug acts as a local irritant to the mucous membrane with which it comes in contact. The biniodide in 2 gr. doses is efficacious and

the citrate also answers well (Murrell). MacDonald reports good results in several cases of amenorrhœa with mental disease, and advocates the same dose of permanganate for three months at least (Pract., 1888). Dr. Braithwaite (Leeds) obtained no good effects (B. M. J., i., 1887) in anæmic cases, but in the fairly healthy with accidental suppression, from such causes as a sea voyage or change of climate, the effect is good (Edin. Med. Journ., 1887, abstract)—1 gr. thrice daily was given up to a week before the period, then 2 gr. In a careful paper by Dr. W. Stephenson (Aberdeen) relief is recorded not only to the amenorrhœa, but to headache, leucorrhœa, and sometimes menorrhagia (B. M. J., ii., 1889). Leffmann and Dr. F. Martin of Chicago (Med. Times, ii., 1885) prefer the binocide, and the latter states that doses of 2 to $2\frac{1}{2}$ gr. every four hours promptly cure amenorrhœa and menorrhagia. Dr. Upshur (Richmond, Va.) reports especially good results in membranous dysmenorrhœa from the same remedy (Trans. Ninth Intern. Congress, 1887). Stockman doubts its value.

Hepatic Disorder.—I have already mentioned that Ure found 1 to 2 dr. of the sulphate act as a cholagogue purgative, and Goolden gave it in cases of enlarged liver with dark or pale stools and jaundice, when no abscess or acute symptoms were present. Most of the patients (at the Dreadnought Hospital) were in a weak condition, having returned from India, and he sought for a non-mercurial remedy to stimulate the liver, and found that 10 or 20 gr. of sulphate of manganese, though at first it excited nausea or vomiting, soon acted on the bowels to the marked relief of the patient, and with rapid clearing away of the jaundice (Lancet, 1840). This favourable result has not been corroborated by others, but Dr. Goolden has written further, stating that he has used the remedy with success in hepatic dropsy, hæmorrhoids, bronchial congestion, hypochondriasis, etc., combining it usually with Epsom salts, in a glass of effervescent water (Lancet, i., 1878).

Gastrodynia.—Pyrosis.—Leared found that oxide of manganese had decided power in relieving these disorders: in the cases in which he describes benefit, epigastric pain severe and radiating, coming on not immediately but soon after food, especially after albuminous food, were the prominent symptoms. Pyrosis and vomiting were sometimes present. In these cases the tongue

was generally red and patchy, and the malady connected with a too rapid shedding of the epithelium and the exposure of a hyper-sensitive mucous surface. Bismuth is a usual and excellent remedy for such a condition, but Leared found manganese relieve it often more quickly, without causing constipation (Ranking, i., 1864). He reports two cases of gastralgia, "severe pain with occasional vomiting," one case of derangement of the stomach sympathetic with that of the uterus, and one of pyrosis, with "irritable mucous membrane": all these got well rather quickly with 10 gr. doses of the oxide (Lancet, i., 1864; ii., 1865). It has been found "gritty and unpleasant" (Rogers).

Diabetes.—Minin has written to recommend the permanganate of potassium in this disorder (Prog. Méd., 1894), but it has not met with general acceptance.

PREPARATIONS AND DOSE.—*Manganesii oxidum nigrum*: dose, 5 to 10 gr. *Manganesii sulphas*: dose, 10 to 20 gr. as a purgative. *Ferri et manganesii carbonas saccharata*: (not off.) dose, 5 to 10 gr. as a hæmatinic. *Potassii permanganas*: dose, 1 to 3 gr. Liquor, 1 per cent. Solutions of manganese salts (1 per cent.) are apt to change colour on exposure to the air. A phosphate, glycerophosphate and hypophosphite are sometimes used, and there is a liquor ferri manganesii peptonatis. Permanganate of sodium is a cheap disinfectant. Permanganate of zinc is suitable for astringent lotions, and permanganate of calcium for a mouth wash. Mineral waters containing manganese are at Luxeuil and at Crausac (L'Aveyron), and it is an ingredient in the "Pepto-Mangan" of Gude, the "Fermanglobin" of Squire and some other special preparations.

NICKEL, Ni = 58.6. (Not official.)

This is a white malleable metal (of specific gravity 8.8) which occurs in nature combined with arsenic (Kupfernickel NiAs). It forms two oxides, the monoxide, NiO, and the sesquioxide, Ni₂O₃. The compounds of this metal are hardly ever used medicinally, but a few observations have been made on their

PHYSIOLOGICAL ACTION.—Schutz gave as much as 10.5 gr. of the acetate to a dog without any result, he therefore concluded that there is no danger in using nickel-plated vessels

for cooking, especially as so little enters into solution under such circumstances. Anderson Stuart found that large doses administered to frogs hypodermically, affected the spinal cord and caused tetanic spasms, and, in short, that the physiological action of nickel is identical with that of cobalt (*q. v.*). Drs. M'Kendrick and Snodgrass have experimented with the carbon monoxide of nickel, $\text{Ni}(\text{CO})_4$, which is a clear liquid, soluble in alcohol, etc., and so volatile as to require to be kept in sealed tubes; they found it a respiratory poison which depressed temperature, and reported it as not yet available for therapeutics (B. M. J., i., 1891). Professor Ch. Richet found it displace the oxygen of hæmoglobin: the vapour caused headache (Rev. des Sc. Méd., 1892). Illness and death amongst men at chemical works have been traced to its inhalation. It caused œdema of the lungs and asphyxia, and its hypodermic injection was fatal (to animals) (B. M. J., i., 1903). Dr. Blake classes nickel with cobalt, iron, manganese and other metals with which it is isomorphous, and says that all cause death in the same way, *viz.*, by arresting the heart. Nickel like cobalt also causes slight contraction of vessels. Professor Da Costa of Philadelphia (Med. Times, 1883) has investigated various salts of nickel, and he found that the sulphate and bromide are best, and are tolerated in small doses, but any amount over 5 gr. causes nausea and giddiness.

THERAPEUTICAL ACTION.—*External.*—The oleate of nickel has a local astringent action, and has been recommended in ointment, especially by Dr. Shoemaker, in diseases of the nails, epithelial ulcerations, old callous ulcers and chronic eczemas.

THERAPEUTICAL ACTION.—*Internal.*—The sulphate and chloride in small doses (1 to 3 gr.) are stated by Professor Da Costa to be serviceable in obstinate diarrhœa; they are sedative in their action, but the bromide is more trustworthy. Speaking generally, it acts on the nervous system like the other bromides in epilepsy and congestive nervous disorders, but careful observations of eight cases by Bourneville at the Bicêtre showed its use to be followed by continuance or increase of attacks (Pract., 1889).

PREPARATIONS AND DOSE.—*Niccoli bromidum*: $\frac{3}{4}$ gr. in pill to 5 gr. in syrup, soluble in water, alcohol and ether. *Niccoli sulphas*: $\frac{1}{2}$ to 1 gr., two or three times daily after food (greenish crystals soluble in water). *Niccoli oleas*: 5 to 20 gr. to the ounce of lard or other basis, as ointment.

PLUMBUM—LEAD, $\text{Pb} = 207$ (205.35). (*Not official.*)

This metal, which does not occur in the native state, is often found combined with sulphur or oxygen. Its commonest ore is galena, a glistening grey sulphide, PbS , from which the metal is obtained by roasting it in a current of air; it is not used in medicine.

COMPOUNDS OF LEAD.

PLUMBI OXIDUM—LEAD OXIDE—LITHARGE ($\text{PbO} = 223$).

CHARACTERS AND TESTS.—It occurs in small glistening red or yellowish-red scales, which should dissolve without effervescence in dilute acids, but after exposure for some time to the air, the scales slowly absorb carbonic acid and may then give some effervescence; they are soluble also in excess of caustic potash solution.

The following *tests* are applicable to this, and to all soluble salts of lead: (1) Sulphuric acid and soluble sulphates give a white precipitate (sulphate of lead) insoluble in dilute acids; (2) Iodide or chromate of potassium gives a yellow precipitate of iodide or chromate of lead respectively; (3) Sulphuretted hydrogen or sulphide of ammonium gives a black precipitate of sulphide of lead, but if the proportion of lead be minute, the colour is brown rather than black.

PLUMBI ACETAS—LEAD ACETATE—"SUGAR OF LEAD" ($\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 3\text{H}_2\text{O} = 379$).

CHARACTERS.—It occurs in white crystalline lumps not unlike sugar, or in large four-sided prisms. The odour is somewhat acetous and the taste, at first sweet, is afterwards astringent. It effloresces in air, and is soluble in water; with distilled water the solution is clear, but with ordinary water it is turbid, from the formation of carbonate of lead with the alkaline carbonates always contained in such water; a few drops of acetic acid will dissolve the carbonate and clear the solution.

LIQUOR PLUMBI SUBACETATIS FORTIS—STRONG SOLUTION OF LEAD SUBACETATE—"GOULARD EXTRACT" ($\text{Pb}_2\text{O}(\text{C}_2\text{H}_3\text{O}_2)_2 = 548$).

CHARACTERS.—A colourless liquid of alkaline reaction and sweetish astringent taste. It quickly absorbs carbonic acid from the air, and becomes turbid from formation of carbonate. It gives precipitates with most vegetable colouring matters, with tannin, and with many animal substances,

especially albumin. With gum acacia it forms an opaque white jelly, which the acetate of lead does not. Its specific gravity is 1.275. It answers to the other tests of lead already mentioned.

Liquor plumbi subacetatis dilutus contains one part of the foregoing, mixed with 79 parts of water.

PLUMBI CARBONAS—LEAD CARBONATE—"WHITE LEAD" ($2\text{PbCO}_3\text{Pb(OH)}_2 = 775$).

CHARACTERS.—A heavy white powder, insoluble in water, but readily soluble in dilute acids, with effervescence: it is a mixture of carbonate and hydrate.

PLUMBI IODIDUM—IODIDE OF LEAD ($\text{PbI}_2 = 461$).

CHARACTERS.—A bright yellow powder, darkened by heat, almost insoluble in cold water, soluble in boiling water, from which it is deposited in golden crystalline scales; soluble in solution of acetate of sodium. It fuses and sublimes yellow, but soon gives off violet vapour.

PLUMBI NITRAS—NITRATE OF LEAD ($\text{Pb(NO}_3)_2 = 331$).

(*Not official.*)

CHARACTERS.—Octahedral crystals of white waxy appearance, and sweetish, astringent taste, soluble in water and alcohol, not efflorescent.

ABSORPTION AND ELIMINATION.—Soluble lead compounds when introduced into the stomach are transformed probably into chloride, but in any case are readily absorbed, as shown by clinical results; it is presumed that they circulate mainly as albuminates.

Workers in lead, such as compositors, plumbers and painters, absorb the metal in part by the skin, in part by the lungs, and sometimes directly with the food (from eating with unwashed hands), while injurious effects are not uncommon from the application of cosmetics and dyes containing lead to the skin and hair. Once within the system lead remains for a long time, in small quantities at least, and may be deposited in different organs. It has been proved to pass through the placenta to the foetus (Porak) and has been found not only in the blood and the liver, spleen and kidney, but also in the muscles and bones, and Chatin recovered 3 milligrammes of lead sulphide from 150 grammes of the upper cervical cord—the tissue was dark grey in colour (*Comptes Rendus Soc. de Biol.*, 1862). Mr. Wynter Blyth found in two

cases of lead poisoning which occurred at a lead factory in East London, that the brain contained large quantities of lead, in one case as much as 117·1 milligrammes of sulphate. He considers that this large amount may account for the serious nervous effects that absorption of the metal produces (Proc. Chem. Soc., London, 1887). Ebstein records the case of a man, aged forty-three, a lacquerer, who had had lead colic for eight years; there was no blue line on the gums. Lead was not found in the muscles, but it was in the brain, yet there was no encephalopathy (Virchow's Archiv, vol. cxxxiv.).

Lead is *eliminated* chiefly in the form of chloride through the liver, kidneys, skin and mucous membranes, especially those of the urinary tract; the process is markedly promoted by iodide of potassium,—iodide of lead, which is excreted with comparative ease, being formed.

PHYSIOLOGICAL ACTION.—*External.*—Solutions of acetate and nitrate of lead, if not too strong, exert a local astringent and sedative action, coagulating albumin and contracting the vessels, thus controlling congestion if present; on the other hand, if the solution be too strong, and be applied to a delicate part, such as the conjunctiva, it excites severe irritation. The carbonate of lead, applied in fine powder, is sedative and slightly astringent. The iodide is slightly stimulant and absorbent. The nitrate and chloride decompose sulphuretted hydrogen combining with the sulphur, and hence they act as deodorants.

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—The acetate of lead is the only salt of this metal given internally, and the effect of moderate medicinal doses upon the intestinal tract is to diminish its secretions, including the bile (Rutherford), and to occasion sometimes slight colic. The more pronounced effects of poisonous doses vary with the mode of receiving them, and may be acute, sub-acute, or chronic in character.

Acute Poisoning.—After a dose of from 1 to 2 oz. the symptoms begin quickly with the characteristic taste of the drug, followed, perhaps, in a quarter of an hour by sensations of burning and pricking in the gullet, nausea and vomiting, but the vomiting caused by the poison alone is not usually severe; there is uneasiness in the stomach sometimes followed by violent colic, but the pain intermits, and it may be relieved by pressure. There is

usually constipation, but sometimes an attack of purging, the faeces being dark and containing lead sulphide; sometimes there is extreme collapse. If recovery ensues, there may occur afterwards symptoms of chronic lead poisoning caused by the absorbed metal.

Sub-acute poisoning may be illustrated by cases which occurred at Stourbridge in 1849, when acetate of lead was mixed by accident with flour at a miller's. Upwards of 500 persons were attacked, a few days after eating the bread, with sensations of constriction about the throat and stomach, cramping pain near the umbilicus, and rigidity of the abdominal muscles; sickness occurred only in a minority of the cases, and did not last long; there was obstinate constipation and a general lessening of secretion; a dark-blue line on the gums was noted. No cases were fatal, but severe symptoms continued for a long time, and sometimes recurred after apparent convalescence.

The subject of *chronic lead poisoning* is exceedingly interesting to the practical physician, but concerns us at present only as illustrating the physiological action of the drug. Some of its symptoms have occurred from the medicinal use of the acetate, and from the continued use of minute quantities rather than from massive doses. Thus Sir R. Christison gave 18 gr. in two days without injurious effects, whilst $\frac{1}{15}$ gr. given two or three times daily for two months caused fatal poisoning in a child (Letheby, Taylor). As a rule, it may be said that the worst effects of any medicinal use of lead limit themselves to an attack of colic, and the severe symptoms about to be described need not be feared from it: 5 gr. doses of acetate have been largely used at the Brompton Hospital without bad results.

The ordinary "lead colic," or plumbism, is traceable most frequently either to the mechanical use of metallic lead, its oxides or carbonates, or to the ingestion of these salts dissolved in drinking water, etc. After some general malaise, disordered taste, dryness of the mouth, foetid breath, anorexia and constipation, abdominal pain will usually be the most marked symptom, but is not so invariably; Sir A. Garrod finds it absent in 2 to 3 per cent. of the cases. When fully developed it is much more intense than ordinary colic; it is referred mainly to the region of the navel (the colon), but severe cramp-like or neuralgic pains dart in many

directions, towards the loins, the scrotum, the chest, and the thighs: it has a twisting, tearing character, so that German miners name it commonly "Hütten Katze" ("cat of mines"). It comes on in paroxysms, remaining constant but dull in the intervals, and the whole attack lasting from a few minutes to several hours; it is often worse at night, but its recurrence is irregular. Relief is found from firm pressure and altered position, and the sufferer either lies flat on his face pressing the abdomen, or is doubled up, bending his legs, or rises suddenly, still pressing the painful part with his hands, till a violent paroxysm again sends him to bed. Restlessness is extreme, and the whole attention is concentrated on the pain. The abdominal walls are rigid, knotty, and drawn in, there is commonly tenesmus, and the rectum has been felt to contract and relax spasmodically. The liver is retracted (Potain) or actually lessened in size; the intestines also are drawn into less space from contraction of their muscular coat, and in prolonged cases, after the abdominal fat has been absorbed, the retraction of the belly becomes very striking.

Tanquerel (*Traité des Maladies de Plomb*, Paris, 1839) and Burton (*Med.-Chir. Trans.*, 1840) were the first to describe as common in plumbism a dark-blue or grey line along the free edge of the gum, together with a brownish coloration of the teeth. Though a valuable sign and often present it is not always so, nor does it necessarily imply saturation of the system with the mineral; it varies in its time of appearance according to the dose, but has been seen within twenty-four hours of administration of one large quantity (Burton): 20 to 30 gr. in divided doses may develop it, and when once seen it is very persistent, lasting twelve months at least after its cause has ceased (Oliver); similar coloured patches may often be found on the buccal mucous membrane. The colouring depends on the formation and deposition of lead sulphide from the sulphuretted hydrogen evolved from particles of food left about the teeth (Tomes), and by perfect cleanliness it may be prevented. According to Hilton Fagge it is distributed in rounded loops corresponding with the vascular papillæ of the mucous membrane, and depends on small pigmented granules, some of which are external to, and others within the small vessels. He concludes that the gas from food-particles diffuses into the textures of the gum, and then com-

bins with lead circulating in the blood or lymph, so that particles of lead sulphide are really precipitated—a similar condition may be present in the intestinal membrane. Iodide of potassium sometimes induces its rapid development (*Lancet*, i., 1876).

We cannot so readily explain the pathology of the colic. It is in part dependent on constipation, for it is relieved when purgation is secured; yet Briquet claims to have relieved it more quickly by faradism of the abdominal wall without any aperient effect. It is dependent partly also on irregular muscular contraction of the intestinal tube, and is partly enteric neuralgia. Harnack using the triethylate of lead, which can be injected directly into the blood, found that the nervous ganglia in the intestinal wall were stimulated, in consequence of which sometimes diarrhoea resulted from increase of peristalsis, but more usually there was firm contraction of the intestine leading to severe constipation; the former was more often seen in animals, the latter in man; the contraction of the bowel, he held, explained the colic (*Archiv f. expt. Path.*, ix.). It is probable, however, that the irregular muscular contraction of the intestinal wall, which is the physical basis of the colic, is due not to a direct action of the lead on the muscular fibre, but to an indirect action through the nervous system.

In acute poisoning, the gastro-intestinal mucous membrane has been found coated with a whitish-grey layer of coagulated mucus containing the poison, and there have been patches of abrasion, congestion, or inflammation observed. In chronic cases the mucous membrane is congested, softened and discoloured, the walls are thickened and the canal irregularly contracted; sometimes intussusceptions are found; the coils of intestine are closely packed together. In chronic plumbism emaciation is notable, especially about the face.

Neuro-muscular System.—Ordinary medicinal doses do not usually produce definite effects on the nerve or muscles, but in acute poisoning from large quantities, besides the pain and cramp already mentioned, general prostration is a marked symptom. There may be also giddiness or stupor, numbness, paralysis, or epileptiform attacks, while in fatal cases convulsions and tremor generally occur. In the sub-acute cases at Stourbridge the neuro-muscular symptoms were cramp and rigidity of

muscles, numbness, with partial palsy of the lower extremities, and collapse: the mental faculties were unimpaired.

But it is in chronic plumbism that affections of the nerves and muscles become marked and significant, various forms of neuritis and paralysis almost always appearing. The most common is a paralysis of the extensor muscles of the wrist and fingers, leading to a condition known as "wrist drop," from the peculiar manner in which the hand hangs down when the limb is extended. This occurs more often, or earlier, on the right side than the left—the fingers and wrists are flexed and the hand pronated, the elbow stands out from the side, and the forearm bends on the arm—wasting of the affected muscles quickly follows, especially of the small muscles of the thumb. A special plastic or fungoid form of synovitis in the sheath of the extensor tendons has been described (Gubler, B. M. J., ii., 1878).

Sometimes other muscles are affected—thus, strabismus has been noted from paralysis of the ocular recti, and aphonia from laryngeal palsy. Death has resulted from paralysis of the respiratory muscles; in a case where this was imminent, recovery occurred under atropine which was presumed to stimulate the respiratory centre (*Lancet*, i., 1889). Although the paralysis is generally of the forearm type, giving the double drop-wrist, yet it is not infrequently of the upper-arm type (in which the deltoid, biceps, and supinator longus are implicated), sometimes it has the characters of an ordinary progressive muscular atrophy (Aran-Duchenne), attacking first the small hand muscles and in about 13 per cent. of the cases it attacks the legs first (peroneal type). Of the special senses sight is the most often affected, amblyopia occurring sometimes without the presence of any changes in the fundus, though double papillitis or neuro-retinitis are not unfrequently seen; Dr. Oliver has recorded, among others, cases of primary papillitis (*Lancet*, ii., 1889), and Dr. Lockhart Gibson has recently described cases in children where there was much swelling of the disc. In these cases there was no albuminuria, but lead was found in the urine (*Med. Ann.*, 1899). Impairment of vision often persists and in some cases ends in absolute blindness. Permanent loss of sight may occur also from a chronic atrophy of the optic nerves independent of papillitis.

It is not uncommon for the hearing to suffer, and common

sensibility is sometimes altered. There are occasionally patches of anæsthesia, and sometimes, as in the Claremont cases, hyperæsthesia is developed. From experiments on animals Curci concludes that lead specially irritates the vagus, and he thus explains the slowing of the heart-action (Record, 1883).

During an attack of lead colic the intellect is, as a rule, clear, but in long-continued cases the moral courage and the spirits give way, and sometimes in the course of the illness distinct delirium occurs, generally of the form "delirium of dread," not unlike delirium tremens. The patient is fearful of being alone, especially at night, and has visions of black and creeping things. Three remarkable illustrations occurring in women-workers at a lead factory are furnished from the London Hospital (Med. Times, i., 1869). The encephalopathic or fulminant cases may result in death in a few hours. In the cases where recovery occurs there may persist blindness or epilepsy or insanity.

The fits which are due to the presence of lead in the blood resemble those of uræmia and alcoholism—and indeed are indistinguishable from true epileptic attacks. Other cerebral symptoms, such as headache, delirium and coma, have been recorded; insomnia is usual. A comparison may be drawn between the effects of alcohol and of lead, both upon the nervous system and the kidneys (Lancet, i., 1889). Of 1,390 cases of lead poisoning there was colic in 88 per cent., paralysis in 7 per cent., and encephalopathy in 5 per cent.

Theories of Plumbism.—Whether the muscles or nerves are primarily affected, and in the latter case whether the peripheral branches or the centres are most at fault, has been much debated. Giacomini attributed the *colic* to direct muscular irritation from deposition of the metal in the abdominal muscles and the diaphragm, pointing out that superficial pressure often gives pain, even over the iliac crests, whilst firm supporting pressure relieves.

Tanquerel maintained that the colic was due to irritation of the great ganglionic centres, though signs of this could only be found in one out of forty post-mortem examinations.

Heubel has argued that the peripheral intra-muscular extremities of nerves are at fault rather than the main trunks (Bleivergiftung, Berlin, 1871). On the other hand, Bernhardt asserts that the real lesion is in the grey matter of the cord (Med. Record,

1878), and most modern observations point to the same conclusion, at least in chronic conditions ; lead has been found in its substance in some cases, and a granular partly atrophic state of spinal cells has been verified in one instance by Lancereaux. Popow finds that lead, like arsenic and mercury, produces a central myelitis of the spinal cord (Virchow's Archiv, 1893). The affected muscles and corresponding nerve-trunks are much atrophied, so that sometimes scarcely one normal fibre can be found. The view that the nerve-centres are the seats of the lesion is also supported by the observation of Wynter Blyth, who found large quantities of lead in both cerebrum and cerebellum. In animals choreic movements occur, and even convulsions, without impairment of sensation or consciousness ; it would thus seem that the motor areas of the central nervous system are more affected than the sensory.

Harnack, as previously stated, explains the colic by an action on the intestinal ganglia. He holds that the action on the muscles is a primary one, although certain observers have stated it to be secondary to degeneration in the spinal cord. In acute poisoning, before any affection of the cord has had time to affect the muscles, he describes the latter as being easily fatigued so that they cannot be tetanised by repeated electric stimulation.

Recent research has shown that it is more than likely that the whole neuron is affected by the lead poison. The peripheral nerves are undoubtedly degenerated, but the fact—to mention but one—that the supinator longus escapes in the ordinary wrist-drop probably indicates an affection of the centres in the cord as well.

Of the cerebral phenomena, to which the term *Saturnine encephalopathies* has been applied, epileptiform convulsions are the most common ; they may occur early and come on suddenly without warning, and are usually accompanied by headache, vertigo and dimness of vision. The convulsions which ensue later are usually associated with an albuminous condition of the urine.

Circulatory System.—Full medicinal doses of the acetate slightly lower the force and frequency of the pulse (Laidlaw). In hæmorrhagic cases and in pneumonia this effect is often marked. Strohl found a diminution of ten to fifteen beats per minute after daily doses of 25 to 50 centigrammes, and Rabuteau verified a pulse-rate below that of health ; it has been explained by a direct action on the muscular structure of the heart. In cases of *acute*

lead poisoning the pulse has been sometimes quickened, but has become slow in the stage of collapse. In *sub-acute* cases it is markedly slow and feeble. During a paroxysm of colic in the course of plumbism the pulse is of characteristic wiry hardness, and generally lowered in frequency, while the heart's action is so weakened as to be scarcely perceptible. In half the large number of cases recorded by Tanquerel the pulse rate was from 30 to 60 per minute, the hardness and slowness being usually proportional to the amount of pain; exceptionally the frequency was increased. The peripheral circulation is commonly impeded, and arterial anæmia leads to pallor and chilliness, though in two cases recorded by Murchison a rise of temperature (102°) was found (Lancet, i., 1868). In *chronic* conditions of lead poisoning the pulse is small, hard and usually slow, and the sallow, bloodless skin has an icteric tint, anæmia is commonly marked, and there is more than the normal amount of liquor sanguinis, as well as fewer red corpuscles; Malassez states, moreover, that these are increased in size (Archives de Physiol., 1874). Cardiac murmurs are common in lead workers, and it is said that the heart and great vessels have been found smaller than usual after death. Henle considers that the vessels are contracted (during life) by direct irritation of their muscular coat by lead circulating with the blood; certainly vascular tension is much increased in plumbism, as clearly shown by the sphygmograms of Dr. A. Frank (Deut. Arch. klin. Med., Bd. xvi.). Some German observers, besides corroborating this, have demonstrated the antagonistic effect of pilocarpine during attacks of colic: very soon after its hypodermic injection the tracing shows greatly lessened tension, and simultaneously the pain is relieved. Nitrite of amyl acts similarly (Med. Record, 1876).

Genito-urinary System.—Chronic lead poisoning often leads to abortion, and if this does not occur, the children born are delicate. Of 123 conceptions amongst lead workers, fifty children only were born alive, and of these but fourteen survived infancy. Dr. Swan records three cases in which abortion occurred (B. M. J., 1889). It would seem that the influence of one parent only affected by lead is enough to produce these results (M. Paul, Archives de Méd., 1860). Amenorrhœa and menorrhagia have been traced to working in lead, and pills of diachylon have been

largely used to procure abortion, especially in factory towns (B. M. J., i., 1902).

The influence exerted by this drug upon the kidney is of great practical importance ; albuminuria is not uncommon in acute plumbism, and is then connected probably with an altered condition of the blood, but in chronic cases a directly injurious action is exerted on the kidney structure, leading to chronic interstitial nephritis. It is said to be due to the deposition of earthy matter in the looped tubules causing their blocking and consequent cirrhosis. Dr. Shearman has recorded two remarkable instances of albuminuria in one family, traceable to the use of drinking water impregnated with lead ; characteristic palsy was also present. The cases recovered for a time after removing the cause, but later one died of apoplexy, the other of Bright's disease (Pract., vol. xii.). In a clinical lecture on the subject Dr. Thomas Oliver concluded lead to be a "special poison to the renal cells" (B. M. J., ii., 1885) ; but all metals, if absorbed, affect the kidneys more or less severely. Brunelle noticed in eleven out of twenty-one cases of lead colic, alimentary glycosuria ; as a rule the glycosuria disappeared with the colic (Arch. Gén. de Méd., 1894).

During a paroxysm of colic the amount of urine is diminished, and it is passed with difficulty. It is proved also that the excretion of urates, urea and uric acid from the blood in its passage through the kidneys is lessened under the influence of lead, hence a larger than normal amount remains in the blood and the patient becomes exposed to gouty attacks. Indeed, Sir A. Garrod has developed acute gout in susceptible subjects by the administration of lead salts, and has calculated that 33 per cent. of gouty patients had been exposed in some manner to the action of lead. Pains about the joints and deposits of urates are not uncommon in saturnine cachexia.

Glandular System.—By the ordinary medicinal use of the drug all secretions are diminished. Heubel attributes the icteric condition frequent in plumbism to contraction of the muscular fibres of the bile-ducts. During an attack of colic all the secretions are diminished except that of the skin (Alderson, Lumleian Lectures, 1852).

Modes of Chronic Lead Poisoning.—Of the different workers in

lead, oxide of lead, or "white lead" (carbonate), those who grind it in factories are most liable to suffer, though less so now that the powder is ground with water (Taylor); but house-painters and coach-painters, plumbers, pewterers and compositors, makers of certain white glazed cards, hat pressers, bleachers of Brussels lace and glazers of pottery are often affected. Severe symptoms have sometimes arisen from sleeping in a newly painted room, or from breathing the smoke of burning painted wood. Amongst exceptional and little suspected causes of plumbism are the handling of vulcanised rubber and black horse-hair coloured by lead sulphide, the use of hair washes, dyes and cosmetics containing lead salts, breathing dust from "American cloth" whitened with lead salts, and in the process of making yellow cord fusees (chromate of lead). Passler (Munch. med. Woch., Jan., 1894) records the case of an infant one and three quarters year of age who developed lead poisoning from the treatment of a general eczema with diachylon ointment. Poisonous symptoms have followed in an infant after the application of strong lead lotions or "metallic shields" (Lancet, ii., 1892) to the mother's nipples, and in children from yellow confectionery (chromate). Chewing "tea lead" (in which tea is wrapped), using snuff that had been wrapped in similar "foil," the use of soda water from lead syphons (B. M. J., 1874-75)—(free tartaric acid is said to help in this case)—bathing in water impregnated from a leaden pipe, drinking wine from bottles which had been cleansed with shot—have all caused plumbism. More recently (Centralb. f. inn. Med., June, 1897) cases of lead poisoning have been recorded in a shoemaker from putting nails in his mouth, in a cigar roller from cutting cigars on a lead plate and putting the knife in his mouth; in a diamond worker who fixed small diamonds in masses of lead before proceeding to cut them; and from the manufacture of artificial flowers (Rev. d'Hyg., Paris, 1897, xix.).

Two epidemics have occurred—one at Taunton, another in France—from flour ground between mill-stones that had been mended with lead (B. M. J., 1877; Med. Times, i., 1878), and even the handling of lead machines, as in ice-cream making, or cameo polishing, or cleaning "beer engines" or brass handles (as engineers do), has induced colic. Cases of lead palsy occurring in children in Australia have been considered due to the drinking

of ginger beer which was found to contain 1 mg. of lead in 24 oz. (Med. Ann., 1897).

There is some reason to think that the "dry colic," or enteric neuralgia of tropical countries is connected with lead. Gubler gives instructive instances of its development from the use of lead cosmetics in creoles (Med. Record, 1876), and it is said to have become more common since steamboats have been more used (Med. Record, 1876). Mialhe and other French physicians also speak of lead colic being frequent on ship-board, and connect it with the action of a saline atmosphere on lead. It is especially frequent in Newcastle, "the home of the lead trade."

But, excepting in the trades first mentioned, the most frequent source of lead poisoning is the use of drinking water impregnated with the metal or some of its compounds. Bad symptoms have resulted from so small an amount as $\frac{1}{16}$ gr. per gallon, and 1 gr. per gallon is a surely dangerous dose. It is to be noted that the freer the water from saline ingredients, the more readily it takes up a soluble carbonate formed on the metal pipe or cistern. The formation and solubility of this are also favoured by much organic impurity, free access of oxygen, a little nitric or other acid or the presence of a second metal (iron as well as lead). Carbonic acid in pure water also favours solubility, although in certain circumstances it may act differently. Lime and other saline constituents will, on the other hand, if present in the water *lessen* the liability to contamination by forming insoluble coatings on the metal: otherwise, no doubt, plumbism would be still more common than it is.

Epidemics have occurred within recent years at Huddersfield, Bradford, Sheffield, Keighley, etc., and in several of these the public water supply from moorland was found acid (B. M. J., i., 1889), and the acidity on which the plumbo-solvency of the water depends has recently been shown to be due to the effect of peat. [Report for Local Med. Board for 1901-2 (B. M. J., i., 1903).]

Idiosyncrasy.—There is a great difference in the susceptibility of different individuals to the poisonous action of lead,—as may be verified in any large factory,—and it is comparable to what has been noticed with arsenical wall papers, etc. One attack of colic predisposes to another, which may follow after a long

interval from a comparatively slight cause—thus a man who had suffered as a house-painter turned gamekeeper and got an attack long afterwards from stirring shot in water with his hands (B. M. J., i., 1877); and a house-painter, who on account of wrist-drop became a college porter, had a relapse a long time after complete recovery, from sitting in a newly painted porter's box. Women and especially girls are more susceptible than men. The most susceptible of all are underfed girls who have been living in bad hygienic surroundings before commencing to work with lead (B. M. J., i., 1877).

SYNERGISTS.—The depressing influence of lead upon the *circulation* is assisted by full doses of digitalis, ergot, veratrum and by prolonged cold (Gubler); its astringent action by metallic salts of copper and zinc particularly. The other metals, especially mercury, antimony and copper, have a similar effect in lessening nutrition.

ANTAGONISTS AND INCOMPATIBLES.—Sulphate and carbonate of calcium, carbonic acid, mineral acids, alkalies, iodide of potassium, albuminous solutions and most vegetable astringents are chemically incompatible, and most of these may be used in the treatment of lead poisoning. In acute cases, when the drug has been taken by the mouth, emetics or the stomach-pump should be used, and sulphate of sodium or magnesium given in milk or mucilage. In chronic cases an alkaline iodide should be given internally, and sulphur baths should be used containing about 7 oz. of sulphuret of potassium or its equivalent. During half an hour of bathing, frictions should be employed, and soap should be freely used afterwards (Eulenburg). Electricity should be applied to the affected muscles—faradism if it causes contraction; if not, the continuous current three or four times weekly for about a quarter of an hour, whether it induces contraction or not: in curable cases it will ultimately do so. Purgatives should be freely given. Castor oil will remove the lead excreted into the intestine: the best results are obtained, however, from magnesium sulphate given with potassium iodide: under the influence of the latter drug the lead is excreted by the bile and intestinal juice and is then immediately removed by the Epsom salts, and thus re-absorption of the poison prevented. Fatty food is said to antagonise the development of plumbism in lead-workers, and a long

prevalent colic in large lead-works in Birmingham was stopped by the free use of a "treacle-beer" containing sulphuric acid (Lancet, i., 1860). Washing the hands before eating, etc., is important, and washing with petroleum is said to be prophylactic (B. M. J., ii., 1877).

Pilocarpine and amyl nitrite antagonise the increased arterial tension which occurs in chronic cases.

THERAPEUTICAL ACTION.—*External.*—**Disinfectant Power.**—A solution of lead nitrate (Ledoyen's disinfectant) has been in use for many years, and acts by decomposing sulphuretted hydrogen and as an antiseptic and germicide; it is comparatively expensive, and its black precipitate is sometimes objectionable: Dr. Goolden has, however, recommended as applicable to many cases solution of *chloride* of lead. He prepares it by dissolving $\frac{1}{2}$ dr. of powdered nitrate of lead in one pint of boiling water, and mixing this with 2 dr. of common salt in 2 gallons of water. The precipitate which falls is in part carbonate of lime, in part carbonate of lead, and the clear supernatant fluid is a saturated solution of lead chloride. This quickly removes the smell of foul drains, ship-holds, etc., and cloths wrung out of it and placed about a room neutralise organic emanations such as from crowded assemblies and foetid suppuration (Lancet, ii., 1875-76; B. M. J., ii., 1876).

Inflamed Surfaces.—A solution of subacetate of lead is still, perhaps, the most frequently used of all remedies in the superficial inflammatory conditions for which it was introduced by Goulard, of Montpellier, more than 100 years ago.

In *erysipelas* it proves cooling and astringent, and a good formula for its use is that given by Christison, Murchison and others (Med. Times, i., 1867), viz., 4 gr. each of lead acetate and of powdered opium in an ounce of warm water. The meconate of lead is formed and is precipitated, but gives an effective therapeutical result; a more elegant form combines the lead salt with acetic acid and acetate of morphine. Dr. Lawson speaks well of a solution of acetate, 10 to 20 gr. in $\frac{1}{2}$ oz. each of plain water and lime-water, for all kinds of *burns*, *wounds* and *ulcers* (Lancet, ii., 1875). Mr. Freer, from much practical experience, recommends the carbonate of lead with linseed oil (white paint) in preference to the acetate, or indeed to any other application; it has the advantage over nitrate of silver of being painless, and it often

relieves very quickly (Lancet, i., 1859). It is good not only in erysipelas, but in burns, carbuncles and eczema, since it excludes the air and exerts a sedative effect; it may be applied with a feather, and a fresh coat put on every two hours or so and left to peel off in a few days. A more elegant mode of using the carbonate is with glycerin, 1 dr. to 4 gr. of the powder, and 1 oz. of cerate; this is useful for erythema.

Conjunctivitis.—Warm lead lotions, with or without opium, are very serviceable in ordinary catarrhal cases, but it is important they should not be ordered if the corneal surface be abraded, or else an opaque white deposit may be left.

Eczema, etc.—In cases of moist discharging eczema, lead lotions are often soothing and sometimes curative; a combination of the liquor plumbi subacetatis 1 oz., with glycerin $\frac{1}{2}$ oz., and cherry laurel water $3\frac{1}{2}$ oz., is very good for sub-acute cases, but may require dilution. Mr. B. Squire gives the preference to a *glycerole* of subacetate of lead, in the preparation of which glycerin is used instead of the water of the official liquor (Med. Times, i., 1876): 1 part of this in 4 of glycerin or of vaseline is a useful strength. Such a preparation under the name *glycerinum plumbi subacetatis* has since become official (B. P., 1885). The lactate of lead is also a good soluble form, but care must be taken that it is not unduly acid from long keeping, as then it is apt to irritate. The liquor plumbi with fresh milk or cream, 1 part in 8 (more or less), forms a lactate and is sometimes a good resource and better borne than the same strength with water. Equal parts of the liquor plumbi and glycerin have given me as good results in chronic eczematous conditions, and more especially in mentagra. In some cases the iodide of lead ointment will be found useful.

The unguentum diachylon is an excellent soothing application where ointment of any kind can be borne, if made properly and according to the following formula (Hebra): Ol. olivæ opt. ʒxv, Pulv. lithargyri ʒiii ʒvi, Aquæ q. s.—Coque. Heat the oil with a pint of water by steam-bath to boiling, the finely powdered litharge being sifted in and stirred continually until the particles disappear; add a few more ounces of water as required and stir till cool. The result should be like butter of a light yellow colour; it is difficult to prepare properly and is apt to decompose.

Lead lotion has been found of service for the treatment of

hæmatoma auris, and it has been recommended as a dressing for bubo; Zeissl kept the surface constantly covered with linen soaked in solution of basic acetate of lead, and found that inflammation and suppuration were much controlled, and convalescence hastened (Med. Times, i., 1872).

Onychia.—Powdered nitrate of lead I have found a remarkably good resource in cases of onychia, and it has quickly benefited when ordinary treatment had failed.

Sore Nipples.—Dr. Fordyce Barker speaks highly of the nitrate of lead (10 to 15 gr. in the ounce of glycerin) as an application to sore nipples (Med. Times, ii., 1873); but the possibility of poisoning the infant should be kept in mind.

Enlarged Glands, etc.—The ointment of lead iodide is often useful in chronic adenitis and splenic enlargements, also in chronic synovitis. It has been found specially useful in acute mastitis when abscess is threatened: steady friction with it relieves pain, enables the milk to be withdrawn, and lessens its secretion. Lead lotion should be applied between the frictions.

Leucorrhœa, etc.—In cases of purulent and muco-purulent discharge from the vagina, the urethra, the ear, or the nose, lead lotion is very useful at any stage, since, if sufficiently dilute, it does not irritate like alum and some other astringents. If, however, improvement is not obtained from weak dilutions the full strength should be tried, and zinc sulphate may be added in the proportion of 1 or 2 gr. to the ounce of lead lotion.

THERAPEUTICAL ACTION.—*Internal.*—**Hæmorrhage.**—The acetate of lead has decided power over many forms of internal hæmorrhage, and is still in frequent use, though not so much so as formerly. Dr. Elliotson often prescribed it in 2 to 3 gr. doses; Dr. Stokes says “nothing can be more striking than its power to arrest the discharge in chronic *bronchial* hæmorrhage,” and I have more than once verified this. Dr. C. J. B. Williams recommends 3 gr. with opium every hour or half-hour in cases of *hæmoptysis*, taking care to give a daily dose of purgative salts (Lancet, i., 1862). In the hæmorrhage of *enteric fever* acetate of lead is often valuable.

In an obstinate case of *hæmaturia*, after failure of tannin, iron and other remedies, grain doses of lead acetate with $\frac{1}{2}$ gr. of opium, given every six hours, soon arrested all bleeding; a blue

line appeared on the gums within a week of this treatment (Gull, *Lancet*, i., 1866). In *uterine hæmorrhage* acetate of lead with opium is often suitable. Dr. Dewees used it largely in plethoric menorrhagia, and in hæmorrhage occurring during pregnancy.

Dr. Workman has written to advocate a novel prescription, which theory would scarcely seem to justify, though the practice is said to be advantageous; he gives the acetate in $\frac{1}{2}$ to 1 dr. doses without any opium; this causes diarrhœa but no other bad symptoms, and produces, he says, the best results in hæmoptysis and also in uterine hæmorrhage, causing contraction of the uterus (*Med. Record*, 1878).

Phthisis.—Chronic Bronchitis.—At one time acetate of lead was thought valuable in consumption, and it may relieve some of the symptoms, such as profuse sweating, expectoration and diarrhœa, but the cases said to be cured by it were probably of chronic bronchitis with excessive secretion. M. Beau has, however, advocated again the advantages of lead treatment in phthisis, recommending the carbonate in gradually increasing doses (*Lancet*, ii., 1861). He founded his practice upon some cases of phthisis which recovered after working in lead-factories, and concludes that a moderate degree of lead poisoning is antagonistic to the malady—but such an opinion is not generally accepted. Nearly all physicians condemn the use of lead salts in phthisis, and with these I fully agree; if only for the impairment of appetite produced, this method of treatment must be objectionable.

Aneurism.—Since the observations of Dupuytren, who reported three cases of aortic aneurism relieved by lead acetate (together with small bleedings and rest), this remedy has been tried by many physicians. Dr. Owen Rees reported a case of acute popliteal aneurism (*Lancet*, i., 1865), with thin walls, and no coagula in the sac, which did not improve under pressure, and was thought incurable without operation; on October 29th 3 gr. of acetate with opium were ordered thrice daily, the diet was not restricted nor rest enforced; on November 1st there was a slight blue line on the gums; on November 5th the dose was increased to 5 gr., and this was continued for twenty-six days, when the remedy was stopped on account of colic: aneurismal pulsation had ceased. On December 31st the man was at work, and on

January 17th was reported cured. This rather striking instance has not been supported by the results of others, though Sir A. Clark reported a case of thoracic aneurism in which 2 gr. of acetate with opium were given thrice daily for two months, and the patient got better; he was kept constantly at rest (*Med. Times*, ii., 1867). Stillé remarks that the sacculated form of aneurism can only be cured by coagulation of blood in the sac, and in so far as acetate of lead promotes this it assists a cure, but in the fusiform aneurism with symmetrical dilatation no mere astringent can exert a salutary power. Bellingham objects to the use of lead in any case, and Mr. T. Holmes, who has known aneurism develop during the course of a lead colic, asserts that the acetate is of no real value in the treatment of the malady (*Lancet*, i., 1872). Bristowe points out that it may help to quiet the circulation, but cannot really coagulate blood within the vessels, otherwise its administration would lead to danger from thrombosis or embolism. From a general review of the evidence I should conclude that although individual cases of apparent benefit may be cited, as a rule but little can be expected in aneurism from the use of lead.

Diarrhœa.—Dysentery.—Stillé has collected a large amount of evidence, American and foreign, in favour of lead acetate as a remedy in many forms of these disorders. Graves and others have recommended it in cholera. It certainly exerts a powerful astringent effect, but should not be used without due regard to the elimination of irritating material by previous purgation if necessary. In some cases of obstinate diarrhœa amongst the ill-fed children of the poor, I have found it exceedingly useful.

PREPARATIONS AND DOSE.—*Plumbi acetat*: dose, 1 to 5 gr.; *pilula plumbi cum opio*: dose, 2 to 4 gr. (contains $12\frac{1}{2}$ per cent. of opium); *suppositoria plumbi composita* (1 gr. of opium and 3 gr. of acetate in each); *plumbi iodidum*: dose, $\frac{1}{4}$ to 1 gr. The following are for external use only: *Plumbi oxidum*; *emplastrum plumbi* (diachylon); *emplastrum plumbi iodidi*; *unguentum plumbi acetatis* (1 in 25 with paraffin ointment); *unguentum glycerini plumbi subacetatis* (contains 1 part of glycerinum plumbi subacetatis in 5 parts of paraffin ointment); *liquor plumbi subacetatis fortis* (Goulard extract); *liquor plumbi subacetatis dilutus* (Goulard water); *glycerinum plumbi subacetatis*; *plumbi carbonas*; *unguentum plumbi carbonatis*; *unguentum plumbi iodidi*; *plumbi oleas* (not off.). The following plasters also contain lead: *Emplastrum belladonnæ*, *saponis*, *calefaciens*, *plumbi*, *plumbi iodidi*, *galbani*, *hydrargyri*, *opii*, *resinæ*.

PLATINUM, $\text{Pt} = 196$ (193.30). (*Not official.*)

This heavy whitish metal is official in the form of "foil," which is used in the analysis by heat of salts of organic acids, etc.

PERCHLORIDE OF PLATINUM SOLUTION (PtCl_4).

It is used as a test to distinguish potassium from sodium and to precipitate ammonium salts.

PHYSIOLOGICAL ACTION.—According to Sir Lauder Brunton, soluble salts of platinum given to frogs paralyse the cerebral centres for voluntary motion, but irritate the intermediate motor centres between the brain and cord, so that, although voluntary motion is diminished, reflex convulsions still occur.

In mammals the peripheral ends of vaso-motor nerves are paralysed, causing diarrhoea with hyperæmia and hæmorrhage from the mucous membranes and abdominal viscera. The excitability of the heart muscle is not affected—that of voluntary muscle is lessened.

PLATINUM BLACK. (*Not official.*)

This has great power of condensing gases, especially oxygen; it is used as a test for amylic alcohol, which it oxidises into valerianic acid.

POTASSIUM—KALIUM, $\text{K} = 39$ (38.83).
(*Not official.*)

This metal has not been found native, but its compounds are very widely diffused. The nitrate occurs in various soils and the chloride in mines, the tartrate in the juice of the grape and other fruits, and carbonate and chloride are found in the ashes of all woods and plants; chloride of potassium abounds especially in the seeds of leguminosæ. From vegetables this salt passes into the animal organism, and hence the milk and the urine of herbivora contain much more of it than the same secretions of carnivora; the blood corpuscles and the contractile substance of muscle contain a comparatively large proportion of it.

CHARACTERS.—The metal itself is soft and silvery-white, so light (its specific gravity being .865) that it floats on water, and with such affinity for oxygen that it decomposes water, thus setting free hydrogen which ignites and burns with a violet purple flame, characteristic of the presence of potassium. Some liquid devoid of oxygen—like benzine—is therefore required in which to keep the metal; if exposed to the air it rapidly oxidises to potash.

COMPOUNDS OF POTASH.

Potassii iodidum (v. Iodine). *Potassii bromidum* (v. Bromine).

LIQUOR POTASSÆ—SOLUTION OF POTASH.

CHARACTERS AND TESTS.—A colourless liquid of acrid taste and strongly alkaline reaction; its specific gravity is 1.058; it contains nearly 6 per cent. of caustic potash, or 27 gr. in the fl. oz.; it feels soapy when rubbed between the fingers on account of its solvent action on the cuticle; it corrodes animal and vegetable substances, and forms soluble soaps with oily and fatty bodies. It is liable to contain carbonate of potassium, lime, sulphates, chlorides and alumina. The best general test for potash salts in solution is perchloride of platinum, which precipitates a yellow double chloride; they communicate a purple colour to a Bunsen or spirit-lamp flame.

POTASSA CAUSTICA—CAUSTIC POTASH—

POTASSIUM HYDROXIDE—POTASSIUM HYDRATE ($\text{KHO} = 56$).

CHARACTERS AND TESTS.—It occurs in hard pencils, which should be white, but which are often bluish in colour; of peculiar odour and acrid taste. It has a strong affinity for water and carbonic acid, and readily deliquesces if exposed to the air: it is soluble also in alcohol. Heat is evolved during its solution in water.

POTASSII CARBONAS—POTASSIUM CARBONATE

($\text{K}_2\text{CO}_3 = 138$).

CHARACTERS AND TESTS.—Obtained from wood ashes, it occurs in small white opaque crystalline grains, having a strong alkaline taste and reaction; it is distinguished from the bicarbonate and from sodium salts by its great affinity for water, for on exposure it soon deliquesces into a thick liquid.

POTASSII BICARBONAS—POTASSIUM BICARBONATE

($\text{KHCO}_3 = 100$).

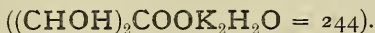
CHARACTERS AND TESTS.—These crystals are large, transparent, colourless, rhombic prisms, which are not deliquescent and not caustic; they are soluble in four parts of cold, and less than their own weight of boiling water, insoluble in alcohol; alkaline to test paper.

POTASSII ACETAS—POTASSIUM ACETATE

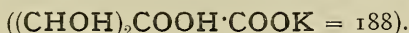
CHARACTERS AND TESTS.—It occurs in long masses of white, smooth, glistening crystals, which are soft, fibrous in texture, and unctuous to the touch; neutral in reaction, very deliquescent, and soluble in alcohol as well as in water.

POTASSII CITRAS—POTASSIUM CITRATE

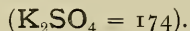
CHARACTERS AND TESTS.—Citrate of potash is a white, granular, crystalline powder, deliquescent, soluble in water, insoluble in alcohol. It is charred by hot sulphuric acid, and its solution gives a precipitate with chloride of calcium only when boiled—a test which distinguishes it from tartrate of potassium.

POTASSII TARTRAS—POTASSIUM TARTRATE

CHARACTERS.—It occurs in small granular crystals, deliquescent, soluble, neutral in reaction, and somewhat bitter in taste.

*POTASSII TARTRAS ACIDUS—ACID POTASSIUM**TARTRATE—PURIFIED CREAM OF TARTAR*

CHARACTERS AND TESTS.—It occurs as a gritty white powder, or in fragments of cakes. It is distinguished from the neutral tartrate by its very sparing solubility in water, *viz.*, 1 in 180 parts: in spirit it is insoluble like other tartrates. It chars on exposure to heat, giving off inflammable gas and an odour of burnt sugar.

POTASSII SULPHAS—POTASSIUM SULPHATE

CHARACTERS AND TESTS.—A very hard crystalline salt, sparingly soluble in cold water; it decrepitates on heating, and has a bitter rather nauseous taste.

*POTASSA SULPHURATA—SULPHURATED POTASH**(HEPAR SULPHURIS).*

CHARACTERS AND TESTS.—From its liver colour when fresh it was formerly called “liver of sulphur,” but it rapidly absorbs oxygen from the air and becomes green and ultimately dull white, sulphate of potassium being formed. It contains various salts, chiefly sulphides, and evolves sulphuretted hydrogen on the addition of any acid.

*POTASSII NITRAS—POTASSIUM NITRATE—NITRE—
SALTPETRE* ($\text{KNO}_3 = 101$).

CHARACTERS AND TESTS.—It occurs in white crystalline fragments, or in striated, long, six-sided prisms which are transparent. It is soluble in water and has a cooling taste; at a red heat it deflagrates. When fused and cast into round moulds it is known as “sal prunella”; abroad these are often coloured purple (like a plum : *prunelle*—a *sloe*).

POTASSII CHLORAS—POTASSIUM CHLORATE
($\text{KClO}_3 = 122.5$).

CHARACTERS AND TESTS.—Chlorate of potash occurs in pearly-white, hard, crystalline plates which are slightly soluble in water and have a cooling taste. Rubbed with sulphur, or phosphorus, tannic acid, or catechu, etc., the salt explodes; treated with sulphuric acid it becomes red, and gives off vapours of chlorine peroxide.

POTASSII PERMANGANAS—POTASSIUM PERMANGANATE
($\text{K}_2\text{Mn}_2\text{O}_8 = 158$).

CHARACTERS AND TESTS.—It occurs in dark-purple acicular crystals, one of which will impart its colour to a large quantity of water. It yields up most of its oxygen (five-eighths) very readily; and if only a little spirit be boiled with its solution, it changes to yellowish-brown on account of its reduction to manganate from permanganate. A similar brown stain is left on the hands when washed in it, on account of the oxidation of the organic skin substance. In distilled water the purple colour may remain two years without change. (Manganese stains are removed by oxalic acid—“salts of lemon.”)

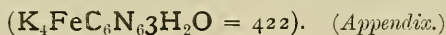
POTASSII BICHROMAS—POTASSIUM BICHRÔMATE
($\text{K}_2\text{CrO}_4, \text{Cr}_2\text{O}_3 = 295$).

CHARACTERS AND TESTS.—It occurs in large, red, transparent four-sided tables soluble in ten times their weight of water. The solution readily gives up part of its oxygen, and when acidified with sulphuric acid, turns green from reduction of the chromic acid and formation of the sulphate of chromium.

POTASSII CYANIDUM—POTASSIUM CYANIDE
($\text{KCN} = 65$). (*Appendix.*)

CHARACTERS AND TESTS.—It occurs in white, opaque, deliquescent crystalline masses, which have the odour of prussic acid, and are soluble in water and in spirit. The aqueous solution has an alkaline reaction.

POTASSII FERROCYANIDUM—POTASSIUM FERROCYANIDE



CHARACTERS AND TESTS.—It occurs in large, yellow crystals, permanent in the air, soluble in water, insoluble in alcohol. It is used in the preparation of dilute hydrocyanic acid and of potassium cyanide, and forms a test solution for ferric salts.

Potassium Ferricyanide ($\text{K}_3\text{Fe}_2\text{C}_{12}\text{N}_{12}$) is included in the appendix to the B. P. as a test for ferrous salts.

ABSORPTION AND ELIMINATION.—*Liquor potassæ* taken on an empty stomach is quickly absorbed; it then combines, probably, with carbonic acid in the blood and is eliminated by the kidneys, mainly in combination with sulphuric acid (Parkes, Med.-Chir. Rev., 1853). When taken with food, or in very small doses at any time, it forms with the gastric acid a chloride, and as such is absorbed.

The *carbonates* when taken in small doses are absorbed as chlorides; of large doses the greater part passes out by the kidneys unchanged: a single large dose (2 dr.) is eliminated more quickly than the same amount given in divided doses (Thompson, Med.-Chir. Rev., ii., 1864). The *acetate*, *citrate* and *tartrate* are reduced in the system to carbonate, and eliminated as such. The *chloride*, *chlorate* and *nitrate* are absorbed very rapidly, and have been detected in the urine, the saliva, etc., within five minutes after being taken.

Much interest attaches to the chemical changes which the *chlorate* undergoes in the system; it was believed to become a chloride, parting with its oxygen to the blood and tissues (Fourcroy), and even the proportion of oxygen furnished was calculated (Garnett). Gubler and some other modern observers also think it possible that a partial reduction of the salt may occur within the body, but it is difficult to reconcile this with the chemical fact of its being found *unchanged* in the urine passed after its administration (Wöhler), as also in the saliva, milk, tears, bronchial mucus, etc. (Isambert). Rabuteau, taking himself small doses, also found the drug *unchanged* in the secretions, and of one large dose of 5 grammes recovered 4.873 grammes from the urine within thirty-six hours (Gaz. Méd. de Paris, 1868). Hence it seems improbable that the chlorate should decompose and give up oxygen at the

temperature of the body, and yet there is some clinical evidence of its improving oxygenation in whatever mode this may be effected. Dr. H. Leffmann has shown the improbability of the theory of *direct* oxygenation by means of potassium chlorate, pointing out that although it yields oxygen in the laboratory at a red heat, yet at the temperature of the body in contact with artificial gastric juice it does not yield oxygen sufficient to combine with 1.50 gr. of phosphorus (Pract., ii., 1884). Potassium permanganate also, which is a good oxidising agent outside the body, is of no avail for that purpose after being swallowed.

When *nitrate* of potassium has been taken in large doses (270 gr. in twenty-four hours) the greater part has been found unchanged in the urine—the rest probably passing as sulphate by the intestines (Taylor, Guy's Reports, 1863); that a certain amount of potassium salt passes off in this manner has been shown by Kramer (Annales d'Hygiène, i., 1843).

PHYSIOLOGICAL ACTION.—*External.*—Caustic potash locally applied has a markedly destructive effect. It forms a soft eschar by dissolving albumin, saponifying fats, and splitting up salts. Weaker solutions are simply irritant, but communicate to the skin a greasy saponaceous feeling from their action on the fatty secretions. The carbonate is much less active, but is also markedly irritant in strong solution. In the bicarbonate, the irritant action has become completely neutralised.

PHYSIOLOGICAL ACTION.—*Internal.*—The *sulphate and acid tartrate* if given in small doses are absorbed from the bowel, and excreted from the blood by the kidneys. In larger doses they act as purgatives, and probably only very minute quantities are then absorbed; they are less diffusible and less easily absorbed than the other salts.

Oxidation and Nutrition.—How far alkalies, as such, contribute to oxidation has long been a question of interest, and it is one of great practical importance. Organic substances, such as bile and hæmoglobin, when exposed to air outside the body, certainly oxidise more quickly when in contact with potash (Chevreul, 1825); olein, again, is not acted on by ozone alone, but if potash be added oxidation sets in at once.

Physiological chemists did not fail to trace a similar action within the body. Lehmann and Mialhe taught that alkalies were

powerful promoters of systemic oxidation, and augmented the excretion of urea and carbonic acid. Liebig fully adopted the same view, teaching that they promoted the combustion of what he termed "respiratory foods," and pointing out that if organic acids (gallic, citric, etc.) were taken alone they passed off almost wholly unchanged, but if in combination with alkalies, *e.g.*, as citrate of potassium, the acid was "burnt off" in the system, and the alkali passed as a carbonate.

Bence Jones concluded that alkalies, though they could not themselves give up oxygen, decidedly assisted oxidation of organic substances within the body by promoting the formation of acids (Lectures and Lancet, i., 1867), and Parkes found, in a series of analyses, that the organic material and sulphuric acid excreted in the urine were markedly increased under the use of liquor potassæ, which acted, he considered, by increasing the oxidation of albuminous tissues; for this effect it had to be given at least eight hours after food (Med.-Chir. Rev., 1853). Similar results did not follow the use of acetate or nitrate of potassium in Parkes's experiments, but Dr. Golding Bird reported a considerable increase of urea and other urinary solids in the case of a dog submitted to the action of 3 dr. of the acetate (On Urinary Deposits).

On the other hand, Rabuteau recorded different results obtained on himself, on Constant (of Smyrna), and on a third person (a woman). Each took 5 to 6 grammes of bicarbonate of sodium or potassium for five to ten days: the full dose of bicarbonate of potassium produced a slight diuretic effect, but 5 grammes none at all; urea was markedly and progressively *diminished*, and depression and anæmia were induced. Analogous results were obtained by Ritter of Nancy.

The explanation of contradictory results obtained by different observers turns largely upon the question of dosage, as with many other medicines. Large quantities like those last referred to will pass out unchanged and quickly, and in their passage so far deteriorate the conditions of the blood and impair the function of the alimentary tract as to induce asthenia and diminish nutrition; (Dr. Ringer regards potassium as a protoplasmic poison;) evidently Dr. Parkes's supposition that increasing the dose of potash will proportionately increase oxidation cannot be sustained. Small doses, on the other hand, not only help to saponify fatty food, but

aid its oxidation and that of carbonaceous material generally, improve the digestion and raise the temperature.

Rabuteau himself confirms these statements, and explains such effects of small doses by their change into *chloride* in the stomach, and their acting as chlorides rather than as alkalies; under the influence of 5 gramme doses of chloride of potassium he found the excretion of urea increased by 20 per cent.

That potassium salts are essential for the development of the animal tissues is shown by the fact that food which in itself is not sufficiently nutritious, such as over-stewed meat, recovers its properties on the addition of these salts and of a little sodium chloride (Binz), whilst the absence of potash salts has been considered to be one cause of scurvy (Garrod). If on the other hand we give meat broth, which is very rich in potash salts, without adding any other nutrient, tissue-change becomes so accelerated that animals thus fed die earlier than others kept without food.

Circulatory System.—A certain amount of potassium salt is essential, as we have seen, for the proper constitution and action of the corpuscles, and the chloride seems to be the best suited for this purpose (Rabuteau); but the prolonged use of the remedy in any combination has an unfavourable effect. Löffler has reported the results in five of his students who took doses of from 1 to 5 dr. of alkaline carbonates for several days, and then allowed blood to be taken from a vein. It was found to be like "cherry juice" in colour and density, the red corpuscles were paler and the white ones more numerous than normal; there was excess of water and of fatty material, and the clot was less firm and elastic than it ought to be (Schmidt's Jahrb., 1848). A curious illustration of the diminished coagulating power of the blood under the influence of nitrate of potash is furnished by Dr. Stevens, who had occasion to bleed a man who had lately taken an ounce of that salt, and was surprised to find the venous blood red and not at all coagulable (Lancet, ii., 1862, quoted by Dr. Basham). In animals after injection of nitrate the result is similar (Rabuteau).

Martin Solon, having analysed blood drawn from the vein of a robust man suffering from acute rheumatism and treated by nitre, found the fibrin diminished, though the inflammatory process was still at its height; ten days afterwards, when the remedy was no longer being taken, the blood-clot was dense and buffed (Bull. de

Théráp., 1843). That the drug cannot, however, be depended upon for antagonising the effects of disease is shown by the fact of fibrinous deposits having been found on the valves of the heart in patients dying during its free administration (*Med. Times*, i., 1863).

Both this salt and the chlorate have the power of rendering venous blood bright red, and much stress was laid upon this change by the early advocates of the direct oxygenation theory (Stevens, O'Shaughnessy, *Lancet*, ii., 1831), but Isambert after making fresh experiments asserts that their statements on this point are incorrect (*Gaz. Méd.*, 1874), and although the change does occur it varies with physical conditions and is dependent rather on altered osmosis than on difference in oxygenation.¹

Several cases of poisoning by potassium chlorate have been recorded (*Berlin. klin. Woch.*, *Med. Times*, and *Deut. med. Woch.*, 1883). The symptoms are those of irritant poisoning—choleraic in character—usually with either suppression of urine or the presence of hæmoglobin or methæmoglobin in the urine. Considerable light has been thrown on these cases by the researches of Dr. J. von Mering, who finds that the chlorate is decomposed in the system with the formation of chloric acid, by the action of carbonic acid upon it (*Monograph*, Berlin, 1885), and the fact that similar symptoms are produced by sodium chlorate shows that they are due to the acid rather than to the base.

In acute cases of poisoning, death results from the conversion of hæmoglobin into methæmoglobin in the blood by the chloric acid; in sub-acute cases, the products of the decomposition of the blood produce occlusion of the renal tubules and death from uræmia. The viscera contain brown masses of altered corpuscles. D'Espine has even argued that the phenomena known as uræmia are really due to accumulation of potash in the blood and its non-elimination by the urine, and he supports this view by analyses in two cases of eclampsia (*Record*, 1884). An instructive case has been reported in which a man who received nearly one ounce of chlorate for use as a gargle drank the whole dissolved in hot water. In half an hour he became faint and thirsty, vomited,

¹ As some clinical evidence of its assisting oxygenation should be noted Mr. Whympers observations of its good effect in relieving headache and other symptoms induced by highly rarefied air, at a height of over 10,000 feet on Chimborazo.

and next day had headache and jaundice; the urine was very scanty and albuminous with sediment of altered blood corpuscles; blood from the finger also showed altered discs; death occurred six days afterwards, suppression of urine continuing; lesions were found in the intestinal tract, liver, spleen and kidney, dependent mainly on excessive blood destruction (Landerer, quoted by Shoemaker). A fatal case of poisoning with chlorate of potassium has been recorded by Jacob (Berl. klin. Woch., July, 1897). A patient aged thirty-nine was admitted comatose thirty hours after taking 25 gm. of the drug = 6½ dr.; there was much dyspnoea and cyanosis and the pulse was thready; at first methæmoglobinuria was observed, but later hæmoglobinuria; death occurred six days after taking the drug. There was leucocytosis and progressive destruction of the red blood corpuscles, also diminished alkalinity. He would not give the drug even as a gargle on account of its destructive action on the blood and its possibly setting up hæmorrhagic nephritis,—an extreme position not likely to be generally adopted. The fatal dose for adults has been put at 3 to 4 dr. in twenty-four hours, and the symptoms described as setting in with rigors which are followed by vomiting and diarrhoea (Copeman in Allbutt., vol. v.). Hofmeier has recorded the case of a child æt. eighteen months, with fatal blood changes after one teaspoonful (Berl. klin. Woch., 1880), and Marchand and Stokers have analysed other cases (Archiv, Leipzig, 1885-87). V. Jaksch describes a sub-acute condition with similar blood, pallor, diarrhoea, etc., from the continued use of smaller doses; he also puts the fatal dose at 3 to 4 dr. (Vergiftungen, 1897); (v. p. 795).

Small doses of the potassium salts (excepting the permanganate) cause a fall in the pulse-rate and in the arterial pressure, probably through the vaso-motor nerves; this effect is usually only temporary, and is followed by a rise of both. *Full* doses lower both pulse-rate and blood-pressure; the lowered pressure may or may not be followed by a rise according to the dose employed. Parkes found a full dose of *liquor potassæ* render the pulse small and slow, but a copious secretion of urine explained this effect. Under the *nitrate* the frequency of the pulse came down in a few days from 76 to 64 (Rabuteau), and the *chlorate*, according to Socquet, has a similar sedative action. Some observers report a *quickened* circulation, especially after venous injection of chlorate (Gubler); Jacobi

speaks of this salt congesting the kidney (Med. Times, i., 1876), and Osborn of its congesting the brain (Lancet, ii., 1859). The observations of Black (1839) and of Bouchardat (1844), and the experiments of Podcopæw (Virchow's Archiv, Bd. xxxiii.), of Guttman, Aubert, Dehn and others agree in assigning to potash salts a distinctively *depressing* effect on the heart-action, both in warm- and cold-blooded animals. Their injection in frogs quickly lessens the force of the blood-current, and finally arrests the heart in diastole; 10 gr. of chloride injected into the jugular vein of the smaller animals cause instant cardiac death, and since the heart-muscle in such cases is found insensitive to electricity (Traube), and since previous section of the vagi has no influence on the result, we conclude that the cardiac arrest is due to a direct paralysis of the muscular substance. This paralysis is commonly preceded by increased activity, but finally it becomes complete, so that the heart-muscle ceases to react to any ordinary stimulus. If, however, the potassium chloride be introduced *gradually* into the system through the stomach, then cardiac contractility is not entirely destroyed by it.

Drs. Ringer and Sainsbury in comparing the effect of salts of potassium, sodium and ammonium on the frog's heart, found that the potassium salts are the most poisonous, both as regards excitability and contractility (Lancet, i., 1882), but the former has also found that the addition of a small quantity of a potassium as well as of a sodium and calcium salt is necessary in order to make an artificial saline circulating fluid for keeping the heart going after its removal from the body (Pract., ii., 1883). Ordinary doses, however, of alkaline potassium salts, given by the mouth, do not introduce into the blood sufficient to cause the depressing effects seen in animals after intravenous injection.

Neuro-muscular System.—Large doses of potassium salts lower the reflex irritability of certain parts of the spinal cord (Binz), but many observers consider this to be only secondary to depression of the circulation; the fall of temperature induced is attributed to the same cause. In warm-blooded animals motor power is weakened, probably from a direct alteration in the *chemical* constitution of muscular elements; the *electrical* reactions are however unchanged. Petrone applied potash salts to exposed intestine and found them excite peristaltic movements upwards and downwards

(Record, 1883). But Rosebach found that the muscular wall of the intestine was paralysed by large doses of the potassium salts. In healthy men a sense of weight and fatigue is often felt in the limbs after absorption of the more easily diffusible salts, as the nitrate, oxalate, chloride, iodide or bromide; local anæsthesia of various parts of the body has been described as a result of drachm doses of the bicarbonate (B. M. J., ii., 1876). There seems to be some idiosyncrasy with regard to such effects, and although full doses usually depress the nervous functions, Dr. Prout refers to pronounced nervous excitement, and even convulsions in some cases, as connected with an excess of alkali, and the chlorate of potassium may cause headache and cerebral congestion. Isambert considered it a nervine sedative, but "this action was not evident in healthy persons" (Med. Times, ii., 1856). Rabuteau finds the "perchlorate" to produce giddiness and other symptoms like those of quinine.

Death produced by large doses in warm-blooded animals is sometimes preceded by convulsions, and is caused by stoppage of the heart (the animal can however be restored by the use of artificial respiration and mechanical irritation of the heart); the nerve-centres are also paralysed, but when on recovery reflex irritability returns, it is found to be much exaggerated.

Glandular System.—Mucous Membranes.—Dilute alkaline solutions taken into the stomach *before* meals augment the secretion of gastric juice (Blondlot, C. Bernard), as do also the chlorides that are formed (Rabuteau). But alkalies given in too large or too concentrated a dose arrest the secretion, and if given soon *after* a meal neutralise the acid which has been already formed. Dr. Ringer formulates a general proposition thus: "Alkalies applied to the orifices of glands with acid secretions increase their secreting power, while alkalies applied in a corresponding way to glands with alkaline secretion lessen or check this secretion;" and I think that, as a general rule, and with due regard to the strength of solution, this may be held true.

The increased secretion of saliva caused by direct application of alkalies is thick, whitish and cloudy; it is not large in amount, and there is some doubt as to whether it is true secretion or (as Kühne thinks) the result of a rapid degeneration of the gland. A similar fluid results from irritation of the sympathetic nerves of

the submaxillary gland, and hence the alkali has been thought to act through the sympathetic. The chlorate of potassium sometimes acts so as to produce a degree of salivation.

Under the influence of alkalies taken internally, the bile and pancreatic juice are rendered more fluid, and thereby increased in amount. The bronchial secretions are also increased and fluidified by alkalies, and the movements of cilia are rendered more active by them.

Secretion from the intestinal glands is augmented, especially by full doses of the potassium salts of mineral acids: 2 or 3 dr. of the sulphate cause watery purging, larger quantities sometimes irritate much: $\frac{1}{2}$ oz. doses have been used in France as an abortifacient with serious effects (Mowbray), and 2 oz. have caused death (Taylor).

The nitrate in small doses is absorbed and produces some constipation, but in full doses and well diluted causes diarrhœa (Martin Solon, 1843). Orfila reported violent irritation of the mucous membrane from its use, and an ounce has caused death with irritant symptoms and depression, though this is exceptional. The experiments of Rognetta indicated only a moderate degree of congestion—no inflammation; and ounce doses, when well diluted, have been given medicinally without serious result.

The chlorate may also irritate mucous membranes, and in large doses has sometimes, though rarely, caused death through this effect, *e.g.*, in a patient with phthisis, who took 300 gr. daily for four days, and in the case of Dr. Fountain, who unfortunately took an ounce in order to prove his conviction of its innocent character (Stillé); 1 dr. every two hours until 2 oz. were taken proved fatal with choleraic symptoms (*cf.* p. 792).

The bichromate in small doses increases all the secretions, and in large doses acts as an irritant poison, causing vomiting, purging and collapse, with suppression of urine.

The urine is often markedly increased in quantity by liquor potassæ (Parkes), by the bicarbonate and the chlorate, but still more by the bitartrate, nitrate, acetate, and citrate; the increase is not always decided, unless the urine is rendered alkaline. There is a marked difference in different compounds as to their production of alkalinity: thus a single dose of 40 gr. of acetate alkalinised the urine in a few hours, and then was not all changed,

but of the bicarbonate several drachm doses were required. In febrile diseases, salines, such as nitrate of potash, may cause at first marked lessening of excretion, afterwards increase (Parkes, *Med. Times*, i., 1855). In cases of irritant poisoning by the potassium salts of the mineral acids suppression of urine has occurred, probably reflex in character.

The observations of Sir Wm. Roberts with serum solutions of uric acid showed that whilst sodium salts hastened its precipitation those of potassium sensibly retarded it, and the carbonate and phosphate, which are alkaline, produced the same effects as the chloride, iodide and bromide, which are neutral, the results being entirely dominated by the nature and quantity of the base, not by the combined acid radicle (*B. M. J.*, ii., 1892).

SYNERGISTS AND ANTAGONISTS.—The other alkalis are allied in chemical action to the salts of potassium, and acids are the chemical antagonists of those which are alkaline. Sir Lauder Brunton and Professor Cash found that by feeding animals with potassium salts the poisonous action of barium might be lessened. Dr. Ringer showed that the prolongation of the cardiac diastole, produced in frogs by calcium salts or by veratrine, can be prevented by potassium salts (*Pract.*, i., 1883).

THERAPEUTICAL ACTION.—*External.*—Caustic potash has been used in surgery for the same purpose as other powerful caustics, and has the special characteristics of being deliquescent, and of dissolving and deeply penetrating the tissues; parts near the seat of its application should therefore be protected by plaster or by oil, and the cauterised place should be sponged with dilute vinegar to prevent undue action. The slough caused by it is leathery, soft, dark-coloured and moist, not dry like that of nitrate of silver; it separates after a variable time, according to its thickness.

Issues.—**Abscess.**—**Bubo, etc.**—For the purpose of making an issue, or of opening a large collection of matter, such as a chronic or “cold” abscess, caustic potash was formerly often, and for the latter purpose is still occasionally, used. Macnamara found better results from it than from the knife in opening bubo (Ranking, i., 1872), and others recommend it in carbuncle. It causes pain but no hæmorrhage, and makes a free opening for the escape of the slough, but antiseptic surgery has practically abolished this treatment.

Burns.—For the relief of burns Poggi has recommended that the burned limb should be immersed in a bath containing a few teaspoonfuls of potassium nitrate or that a bandage saturated with the solution should be applied to the part.

Varix.—**Nævus, etc.**—Caustic potash is said to have the power of obliterating the trunk of a varicose vein (Bonnet), and also of destroying superficial nævi (Wardrop); but the application is painful, and is apt to leave a very evident cicatrix. Powdered nitrate of potassium kept in contact with the nævus has given a better result in slight cases. Half an ounce of a saturated solution of the chlorate with a little opium is a good injection into the rectum for painful hæmorrhoids.

In **Hospital Gangrene** the part may be first dressed with the solid caustic, and afterwards with a lotion containing it in gradually diminishing proportion—400 cases are said to have been treated successfully by this means (Restelle, Brit. For. Rev., 1850).

Strumous Ulceration.—In strumous ulceration of a superficial indolent character with livid undermined edges, and affecting extensive surfaces on the trunk or extremities, caustic potash lightly applied to the margin often stimulates to satisfactory healing.

Lupus.—For cases of ulcerative lupus in which the strumous character is most marked, caustic potash is sometimes a good agent; we do not apply it generally for lupus about the face, because of the unsightly cicatrix which is apt to follow its use, but in Vienna it is in frequent request, and is found to succeed when other remedies have failed. Dr. Robert Liveing recommends it with an equal part of water, and this is a very usual application for lupus exedens even of the face, and has given me excellent results.

Epithelioma.—The disadvantage of the deliquescent character of potash may be obviated, and its efficacy rather increased by combination with caustic lime, two parts of the latter to one of the former constituting “Vienna Paste”; it should be kept dry, and moistened only with a little spirit as required. Epithelioma affecting the lip has been sometimes cured by successive applications of this caustic, but it is painful and tedious.

Uterine Ulceration.—Pure caustic potash has been applied

to ulcerations and hyperplasiæ of the cervix uteri, and although disastrous results such as contraction and cicatrix have occasionally followed, it may be of decided service in skilled hands, not only for irregular ulcerative conditions, but also in chronic cervicitis with induration (areolar hyperplasia); in such cases it may be applied about every ten days for several times, and free injections of vinegar and water should be used afterwards. Dr. Henry Bennet recommended it or the lime compound "as a last resource," and the Vienna paste is sometimes serviceable. French surgeons use the same remedy, with an additional quantity of lime, carefully prepared in lead or iron tubes (caustic of Filhos, of Robiquet). Dr. Herbert Snow brought forward illustrations of its value, but the balance of opinion on discussion was rather against it (B. M. J., i., 1885).

Primary Syphilitic Ulcers, Warts, etc., have been sometimes destroyed by caustic potash. The bichromate is also useful for this purpose.

Leucorrhœa.—Gonorrhœa.—In the former affection, when the discharge is profuse and strongly alkaline and either transparent or white, coming probably from the glands of the cervix uteri, a weak alkaline injection (1 dr. of bicarbonate to the pint) thoroughly applied will often relieve; but injections of solutions of the chlorate (2 dr. to the pint) act better, especially if the discharge be at all purulent (Amer. Med.-Chir. Rev., Nov., 1858). The permanganate should be used if there be a disagreeable odour.

In gonorrhœa, injections of the permanganate (1 to 5 gr. to the ounce) have been highly praised, especially in the second stage (Med. Times, ii., 1862; Lancet, i., 1883). In many cases they certainly act well, but care should be taken to begin with a weak solution, for I have known pain and irritation produced by such injections. The scalding and burning pain in micturition may also be much relieved by the bicarbonate, or perhaps better by the acetate and nitrate given *internally* with mucilage; it is said that the attack may even be cured by them (Lancet, ii., 1850). In chronic cystitis with foetid urine, injections containing the chloride (4 gr. to 1 oz.) are recommended by Dr. Braxton Hicks and by Dr. Shoemaker.

In-growing Nail, etc.—This troublesome affection may be well treated by means of dilute liquor potassæ (2 dr. to the ounce

of water) constantly applied on lint, between the nail and the soft tissues, so as to thin the nail and render it flexible, when it can be rubbed or pared away (Norton, *Lancet*, i., 1869).

Unhealthy Wounds.—Several compounds of potash have valuable disinfectant and also alterative properties, especially the permanganate and the chlorate, and when used in the form of lotion prove of the greatest service in removing fœtor and promoting healthy action. For the *bites of rabid animals* its penetrating and alkaline powers render liquor potassæ valuable; in *snake bite* especially it should be applied locally. If solution of potassium permanganate can be applied locally to snake bites before the poison has had time to be absorbed it destroys the virulence of the poison and acts as a very efficient local antidote (*v. p.* 758). A lotion containing 5 gr. of the chlorate to the ounce is good for burns, especially in the second stage (Brown, *B. M. J.*, ii., 1884).

Stomatitis.—Diphtheria.—In aphthous conditions and unhealthy ulcerations about the gums, palate or tonsils, gargles containing the chlorate or permanganate are very good (*v. p.* 808). In diphtheria both these salts have proved of service. A useful proportion of the permanganate for local application is about 10 gr. to the pint of water.

Eczema.—A weak lotion of bicarbonate of potassium (or of sodium), 30 to 60 gr. in the pint, will often relieve the early discharging stages of eczema, and a stronger application (caustic potash, 5 to 20 gr. in the ounce) is a useful stimulant to patches in the chronic stage; although painful, it markedly relieves the itching, which is often worse than pain. The German school especially have reduced to a system the application of potash in the form of their *sapo viridis* ("Schmier-seife"), which is made by boiling oil with potash and potassium carbonate; it forms a soft amber-green compound, more elegant than our "soft soap." Of this a general bath is prepared with 1 dr. to the pint, a second strength (1 dr. to $\frac{1}{2}$ oz. of water) is used for infiltrated subacute patches, and a third (1 dr. to 2 dr. of water) acts as a caustic for very chronic cases; besides these the German codex contains a "spirit of soap" and other similar preparations. The solution of selected strength should be thoroughly brushed in and the irritation quickly relieved by a stream of cold water. The use of such remedies is painful and causes profuse serous effusion from the

part; before commencing a course of them, vascular irritation should be subdued by cold water, etc., and afterwards it will be found desirable to use some emollient such as glycerin or oil, otherwise the skin becomes harsh and dry. There can be no doubt that in some chronic forms, and especially in chronic eczema of the scalp, the soft soap treatment gives remarkably good results (*Med. Times*, i., 1860). Dr. Unna and others have introduced "fatted" soaps medicated in various ways, which are very useful in eczema, psoriasis, etc.

For subacute patches a 1 to 2 per cent. aqueous solution of potassium permanganate or even a stronger solution has been found serviceable (*Bulkley, Arch. of Ped.*, Feb., 1897; *v.* p. 758).

Sebaceous Disorder.—Acne, etc.—In cases of greasy skin and of obstructed follicles, soft soap is a good remedy. In the former it cleanses and tends to lessen secretion; in the latter it dissolves obstruction, but it should be used cautiously if much inflammation be present. Alkaline drops or injections are useful for softening and evacuating hardened cerumen in the meatus.

Boils and Carbuncles.—Dr. Shoemaker recommends potassium chlorate, both internally and as a dusting powder, in these affections (*Med. Times*, ii., 1882).

Scabies.—Ringworm.—Preparations of potash (soft soap, etc.) are indirectly useful in parasitic disorders by softening the epidermis and removing secretion, and thus allowing the more direct contact of sulphur or similar remedies; hence the carbonate is a frequent ingredient in pomades for scabies.

Psoriasis.—The diffused forms of this disease may be much relieved by alkaline baths (potassium and sodium carbonates together, of each about 3 oz. in the bath), and thickly accumulated scales may be removed by frictions with soft soap. Oil of cade may be usefully combined with the same remedy (soft soap, rectified spirit, oil of cade, equal parts). Hebra applied to severe cases a daily friction with soft soap for many days, not using a bath during the course but keeping the patient in blankets. This is, however, a painful process on account of the great tension of the skin which is induced whenever strong applications of potash are made to the general surface.

Potassium permanganate in solution has recently been recommended as a local application in psoriasis. Rasch has had some

good results by painting a 2 per cent. solution on the diseased areas twice a day (Hospitalstidende, No. 41, 1898).

Lichen.—Urticaria, etc.—Weak solutions of potassium salts or liquor potassæ relieve the itching and irritation of these disorders, also of general pruritus, and to some extent of pruritus vulvæ. A lotion made by boiling $\frac{1}{2}$ oz. of potassa sulphurata in 1 pint of water is very useful.

Bromidrosis.—Gaucher (Journ. des Pract., Oct., 1897) has recommended a 1 or 2 per cent. solution of potassium permanganate in alcohol for this troublesome affection of the feet.

Actinomycosis.—In the incipient and uncomplicated cases of this disease iodide of potassium in doses of 1 to 6 grammes per diem for some weeks has been found efficacious (Berard, Assoc. Franç. pour l'Avancement des Sciences, 1897; v. p. 103).

Rheumatism, Plumbism.—The carbonate of potassium, dissolved in a bath of warm water, is often useful to relieve pain in the joints and irritable eruptions in rheumatic and gouty subjects, and the sulphuret furnishes a bath which stimulates especially the muscular system, and has proved useful in plumbism, etc.

THERAPEUTICAL ACTION.—Internal.—Dyspepsia.—In cases of irritative dyspepsia, especially when occurring in stout and rheumatic or gouty persons, and marked by a red tongue, acid eructations or pyrosis, with nausea and discomfort after meals, the liquor potassæ or potassium bicarbonate taken at that time (*after* meals) often gives relief; in gouty subjects and when the urine is loaded they are to be preferred to soda; in such cases the alkali acts chiefly by neutralising excess of acid. In atonic dyspepsia, however, with a pale coated tongue and much weight after food, small doses of alkali are best given *before* a meal, and if continued for some time should be combined with a bitter infusion;—the alkali stimulates the gastric glands to secrete more abundantly. In “biliousness” with yellowish complexion and conjunctivæ, headache and nausea, and even in actual catarrhal jaundice, salts of potassium are good adjuvants.

In *vomiting* connected with the condition just described, or with other functional or even organic gastric disorder, or occurring at the commencement of inflammatory fevers, the bicarbonate of potassium is advantageously given in effervescence with citric acid.

Acid Poisoning.—In cases of poisoning by the mineral acids, bicarbonate of potassium may be employed not only to neutralise the acid but as an emetic, by giving first a large dose of the alkali, and a suitable quantity of citric acid some minutes afterwards. The amount of carbonic acid evolved distends the stomach so as to assist the discharge of its contents (but if the stomach wall has been much corroded by the acid, the sudden distension caused by the evolution of carbonic acid may induce rupture).

Lithiasis.—Calculus.—In cases of excessive formation of uric acid, potassium salts are useful by assisting oxidation of the acid to some extent, and also by furnishing a base with which it is readily eliminated in a soluble form ; they should be considered, however, rather palliative than curative, and attention should be equally directed to diet and hygiene during their use.

The continued administration of potash had at one time much reputation in the treatment of uric acid calculus, and Sir William Roberts has shown by careful experiments that benefit may be expected from it under certain conditions. It is specially adapted for renal calculi which cannot be reached in any other way, and for small vesical calculi consisting either of uric acid or cystine. The acetate and citrate of potassium are the best to use, and in order to secure a sufficient and continuous alkalescence of the urine, 30 gr. for children, or 40 gr. for adults, of either salt must be taken at intervals of about three hours. This quantity will give to the urine an alkalinity equal to 3 or 4 gr. of carbonate in the pint, which may be kept up for several weeks without injury to the general health, but the urine must be frequently examined, and if it becomes ammoniacal the treatment should be omitted.

The use of large doses to secure continued alkalescence of the urine is not now often prescribed, but in cases of uric acid gravel, as the urine becomes markedly more acid during fasting, and the flow is slower during rest and sleep, the tendency to precipitation in the kidney is greatest in the early morning, and may be obviated by one full dose, say a drachm, of citrate of potash at bedtime, and for a limited period another dose in the early morning if necessary (Roberts). I have seen much advantage from this proceeding, but many other solvents of uric acid are now in vogue ; the combination of potash with piperidine benzoate known as "Calculusol" is one of the best.

Skin Disease.—Several varieties of cutaneous disease are connected with a gouty or rheumatic diathesis, especially forms of eczema and psoriasis; in such cases the urine is often scanty and loaded, and then alkaline diuretics are of service. Mr. Easton has shown the advantages of the acetate (*Edin. Month. Journ.*, 1850); the liquor potassæ is also given successfully.

Acne.—Levisseur (*N. Y. Medical Record*, 11th Nov., 1899) has advocated the use of potassium iodide in old standing cases of acne. It produces a reaction which he compares to that of tuberculin on lupus. He gives 5 gr. three times a day, preferably in milk.

Acute Rheumatism.—At one time alkaline treatment, by potash especially, was accepted as the best for rheumatic fever. Amongst its principal supporters, Dr. Fuller claimed that it would prevent cardiac lesions, for such lesions did not occur in any of a large number of cases thoroughly brought under the influence of alkalies (*Lancet*, ii., 1862). He argued that these remedies did not simply neutralise abnormal acidity, but restored normal alkaline conditions, held the fibrin in solution, exerted a sedative influence on the circulation, and favoured complete metamorphosis of tissue; he pointed out also that for a fair trial correct diagnosis was essential, and that true rheumatism should not be confounded with the gonorrhœal affection, with rheumatoid arthritis, or pyæmia, and such mistakes would account for failures; he approved of a prescription containing ammonium, potassium and sodium salts in combination with citric acid in effervescence. Pribram states very decidedly that more cardiac complications occur under salicylates than under alkalies, and recommends potassium acetate with soda and citric acid till the urine be alkaline, then less frequently (*Nothnagel, Specielle Pathol. u. Therap.*, Bd. v., Wien, 1899), and statistical evidence to the same effect is furnished by Dr. Wm. Ewart in the *Lancet*, i., 1900. Of cases under full alkaline treatment the proportion with cardiac complications was 1 in 54: of cases with salicylates alone 1 in 12; many find it desirable to combine both remedies.

Sir Thomas Watson recommended liquor potassæ, and Dr. Parkes made use of it (*Med.-Chir. Rev.*, 1864), but it is not really so suitable as the neutral salts. Todd preferred the bicarbonate or acetate in $\frac{1}{2}$ dr. doses every three hours (*Ranking*, i., 1869).

Dickinson has written in favour of the same method, and Golding Bird in favour of the acetate specially, whilst Dr. Basham was a constant advocate of the nitrate (*Lancet*, 1848, and ii., 1862); he used large doses, from 1 to 3 oz. daily in 4 pints of barley water. On the other hand, Dr. Sutton asserted that none of these remedies could influence the course of rheumatic fever or prevent heart complications, though they might allay pain (*Med.-Chir. Trans.*, vol. lii.). Dr. Ringer from his own observations came to a similar conclusion, whilst Dr. Ridge and others have argued that they are injurious (*Med. Times*, ii., 1871). No doubt the continued use of large doses may induce depressing anæmia, and consequent tedious convalescence, and now that salicin, the salicylates and other remedies are better known, we are not so dependent on alkaline medication; it must, however, be held a valuable resource in cases marked by a high degree of acidity and loaded urine, and its judicious use may greatly relieve. In my own practice I commonly combine iodide of potassium with bicarbonate in effervescence.

Acute Endocarditis.—Caton has advocated the use of potassium iodide in the early stages of this disease, even before a murmur is developed. He gives it in 10 gr. doses and employs fly blisters applied over the infraclavicular regions and enjoins complete rest. Doubtless this is a useful combination, but considering the known deleterious effect of potassium salts on the heart muscle, it would be better in some cases to employ the sodium or ammonium iodide (*B. M. J.*, i., 1896).

Cardiac Disorder, etc.—Dr. V. N. Sirotinin has drawn attention to the remarkably good effects of potash salts—the nitrate and the acetate in 30 to 90 gr. doses per diem—in cases where cardiac compensation is disturbed as well as in inflammatory lung conditions, such as pneumonia and pleurisy and in ascites; the cardiac tone was improved, the arterial tension increased, the pulse slowed and palpitation relieved; the urine was increased and albuminuria lessened where these effects were produced (*St. Petersburg. Inaug. Diss.*, 1884).

Angina Pectoris.—For the majority of cases, but especially for robust, middle-aged men, the best treatment according to Osler (*New York Med. Jour.*, 19th Dec., 1896) is potassium iodide in doses of 10 to 15 gr. three times daily, continued for two, three or four years. I have used this treatment for the last thirty years

with excellent results in doses of 5 to 10 gr., also in cases of pseudo-angina with still better effect.

Ague.—Nitrate of potassium has been found useful in ague—10 gr. every two or three hours (in brandy); it increases the secretions, notably the perspiration and urine.

Specific Fevers.—Alkalies, especially in effervescence, greatly relieve the thirst and other distressing symptoms in various fevers, and they promote elimination by the skin and the kidneys. The chlorate has been recommended in *enteric* fever by Chomel, but has not been largely given; in *scarlet* fever, I with others have found it of much advantage, doubtless because being excreted in the saliva it has a salutary influence on the throat.

Diphtheria.—Chlorate of potassium in full doses either alone or combined with iodide has seemed very useful to many observers (Squire, Hillier, Perrin, Henoch, Vogel). I quite agree with them; I have for twenty years used it more or less with advantage. In America it is commonly given with chloride of ammonium. Dr. Ciattaglia has recorded his very successful results with doses of 10 to 15 grammes daily; but in addition he thoroughly applied to the affected part a wash of chloral—1 dr. in 5 of glycerin (Lancet, i., 1876). Since the record of fatal results from over-doses of the salt, some fear has been entertained of its harmful effect in diphtheria and other fevers when the alkalinity of the blood is subnormal, and in two fatal cases of diphtheria the post-mortem appearances have been connected with the use of large doses. The maximum is put at 2 dr. per diem for adults, 1 dr. for children, $\frac{1}{2}$ dr. below ten years, 15 gr. for infants (Record, 1884).

The permanganate of potassium has also proved useful in diphtheria, as well internally as locally (Lancet, ii., 1863; Ranking, 1865). I can add my testimony to its value, though it is right to recognise the statements of Dr. H. C. Wood that he “has never seen the chlorate do a particle of good in such maladies as scarlet fever, diphtheria, etc.,” and with regard to the permanganate, “as immediate decomposition of it must occur in the stomach the absurdity of its internal use needs only to be pointed out” (Treatise on Therapeutics).

Liquor potassæ will dissolve fibrinous membrane outside the body, and to some but not to a great extent may be available in the form of spray ($\frac{1}{2}$ or 1 dr. to 1 oz. of water). It has been

compared to mercury in its constitutional effect of promoting absorption, but it acts too slowly to be depended upon for so acute a malady. The bichromate I have occasionally used locally and internally with good effect.

Bronchitis.—Catarrh.—When expectoration is scanty, viscid and difficult, either in early or later stages of bronchitis, alkalies often relieve and may be taken with other expectorants. The liquor potassæ in doses of 10 to 15 min. is one of the most suitable forms: the nitrate is also useful, and is commonly combined with Dover's powder or with antimony and tinct. camph. co. (Graves, Clin. Lect.). Laborde believes the chlorate to be serviceable both in acute and chronic catarrhal bronchitis; in ordinary catarrh I have found the chlorate a very good remedy; it is recommended also by Dr. Sedgwick (B. M. J., i., 1873).

Asthma.—The inhalation of fumes of "nitre paper" is often valuable in this malady, and I with others strongly recommend it, especially for spasmodic asthma, though it is available also in the bronchitic form, if congestion is not very acute. It may be made with thick blotting-paper, saturated in a hot solution of potassium nitrate (4 oz. to $\frac{1}{2}$ pint), then dried and divided as required. In some cases a little of this is sufficient, and a less strength of solution is desirable, but in others relief is not obtained till the room is filled with the vapour (Times, i., 1874). Nitrous acid fumes are given off and exert the anti-spasmodic action of nitrites. "Ozone" papers are said to be prepared with nitrate and chlorate which form also ingredients in Himrod and other "cures." Dr. Murrell has reported much relief from thick strong papers covered with crystals of the nitrate or chlorate; when lighted they give out "dense volumes of smoke" (B. M. J., i., 1881). Sometimes, however, especially if there be extensive or active congestion, such treatment proves irritant, and its first use therefore requires watching.

Perhaps the best treatment in the interval between the paroxysms is potassium iodide in 5 or 6 gr. doses with 2 min. of Fowler's solution thrice daily after meals (v. p. 105).

The cobalto-nitrite of potassium has been used like other nitrites with advantage for the relief of dyspnœa, whether uræmic or emphysematous. It is said to be easily prepared, cheap, stable and safe in doses of $\frac{1}{2}$ gr. every two or three hours or oftener; the

effects begin within an hour and last two or three hours (Roosevelt, N. Y. Journ., 1888). Leech gave 4 gr. doses which lowered tension, but were irregular in their effect owing to its varying solubility—it is less soluble than alkaline nitrates.

Pertussis.—The carbonate of potassium was at one time in good repute in the treatment of whooping-cough, but we cannot expect more from it than the thinning of tracheal and bronchial secretion, and a slight sedative effect on the mucous membrane. The acetate has been especially recommended (Pract., vol. ii.), also the sulphuret; the latter is given in doses of 1 gr. for each year up to four years, after that age in the proportion of $\frac{1}{2}$ gr. per year. It is important that its solution should be freshly prepared; it is rather nauseous, and acts sometimes as an emetic, but if continued for four or five days will usually do good (Ranking, i., 1869).

Pneumonia.—Potassium iodide has been extolled as of great value in the early stages of the croupous pneumonia of adults, especially if administered within the first twenty-four hours (*v. p.* 105).

Phthisis.—Potassium chlorate was for some time believed to be of value in phthisis, but is now discredited.

I have found the bi-carbonate relieve pleuritic stitches, diminish purulent expectoration, and check copious perspiration. The tellurate has proved of service in profuse sweating, one dose being given in twenty-four hours—of about $\frac{1}{2}$ gr. per day or $\frac{1}{3}$ per night in pill—but the garlic odour given to the breath is an objection to its use; it will also control the sweating of healthy subjects when due to hot weather, etc. In the vomiting of phthisis Ferrand has obtained good results by painting a 10 per cent. solution of potassium bromide in glycerin on the pharynx so as to diminish its sensibility (*Rev. de Thér. Méd.-Chir.*).

Chronic Hoarseness. — Aphonia.—In these conditions, whether connected with chronic chest-disorder (not laryngeal phthisis) or with over-exertion in talking or singing, I have frequently prescribed from 5 to 15 min. of liquor potassæ with advantage; in fact this simple remedy, given every four hours for a few days, has quickly relieved and sometimes quite cured the symptoms.

Struma.—Asthenia.—Many physicians at one time attributed benefit to the chlorate in strumous asthenic conditions, more or

less allied to phthisis. Liquor potassæ may sometimes induce the absorption of glandular tumours, but cannot be considered curative of the constitutional taint; it is now practically replaced by iodide of iron and cod-liver oil.

Suppuration.—Ulceration of Mouth.—In cases of suppuration, such as carbuncle or continued eruption of boils, or discharging wounded surfaces, also in sloughing or gangrene, the chlorate and permanganate have been found useful internally as well as locally, but it is especially in ulceration about the mouth, the gums and the fauces that chlorate of potassium is most valuable. Mr. Hutchinson has recorded many cases occurring in unhealthy children, and very obstinate until this remedy was given in full doses of from 10 to 30 gr. (*Med. Times*, ii., 1856). Mr. Hunt introduced it as a specific in ulcerative and gangrenous stomatitis (*Med.-Chir. Trans.*, xxvi.), and I consider it a most valuable remedy when used internally and locally in these affections. In relaxed sore throat and catarrhal pharyngitis the chlorate is often serviceable, and is commonly prescribed in the form of lozenge.

In *mercurial stomatitis* it is very useful, and Ricord administered it with mercury to obviate injurious effects from the latter. Sir T. Watson quotes a formula containing the chlorate, 10 gr. with an equal quantity of sulphur, as “almost a specific,” but my own experience is that the chlorate does not give in mercurial maladies the same good results as in ordinary stomatitis.

Gastric Diseases.—For gastric ulcer, dyspepsia, chronic catarrh and persistent vomiting, potassium bichromate ($\frac{1}{12}$ to $\frac{1}{8}$ gr.) has been found to give relief. For the latter condition at any rate it should be given on an empty stomach. I have frequently used this treatment with great advantage. (Sir Thomas R. Fraser, *Lancet*, i. 1894.)

Diarrhœa.—Marotti considers the acetate valuable in gastrointestinal disorder connected with chronic catarrhal conditions and increased secretion of mucus in the alimentary canal and marked by a coated tongue and anorexia (*Pract.*, vol. ii., 1869), but I think we have more trustworthy remedies. I should rather avoid it in acute conditions of this kind, but in the form connected with advanced stages of chronic nervous disorder and cachexia, or “vaso-paralytic” diarrhœa, its use is more indicated. The chlorate is an ingredient in the “saline” treatment of cholera.

Constipation.—The sulphate of potassium acts as a mild aperient, and is suitable for cases of dyspepsia with deficient biliary secretion or hæmorrhoids; it is often combined with rhubarb, especially for children (West, Hillier). Dr. Dickinson recommends it in doses of 10 to 20 gr. as a good laxative in albuminuria (Lancet, i., 1876); in larger doses it is apt to cause griping. The acid tartrate is also used as an aperient, especially in cases of hæmorrhoids and of dropsy, since it produces a copious watery secretion into the intestinal canal, but it should be combined with some more active agent to secure efficient expulsive effect; thus it is ordered with sulphur in the *confectio sulphuris*, and with jalap in the *pulvis jalapæ compositus*.

Purpura.—Scorbutus.—Hæmorrhage.—In purpura simplex, 10 gr. doses of nitrate of potassium have been sometimes useful, and even in hæmorrhagic purpura the same remedy in large doses (10 to 60 gr.) has been recommended. The advantage of potassium salts in true scurvy is not clear, but for the special ulceration of the gums the chlorate is certainly good (Lancet, ii., 1860, etc.). Both the nitrate and tartrate are of service in the treatment of capillary hæmorrhage; the former and the chlorate have been used especially in hæmoptysis accompanied with febrile excitement, and the latter, and also the succinate, in hæmorrhage from the kidney, bladder and rectum. Potassium iodide has been recommended by Silvester in the treatment of uterine hæmorrhage due to fibroids, in hæmorrhagic endometritis and as a prophylactic in habitual abortion (Gaz. degli Osped. e delle Clin., Nov., 1898). Boquet has found that not only are the hæmorrhage and pain arrested, but that the tumour itself has diminished in size under the use of the iodide (Sem. Méd., March, 1898).

Cirrhosis of the Liver.—The acid tartrate of potassium is said to be “of singular value in alcoholic cirrhosis” (Gull, Lancet, i., 1866), and this observation has been corroborated for other forms of cirrhosis and chronic peritonitis (B. M. J., ii., 1892, and Semaine Méd., 1892). In the latter, benefit is recorded in a case that had been tapped twenty-eight times: from ʒii to ʒiv may be given daily.

Obesity.—There are on record some remarkable cases in which the use of potassium salts and especially of liquor potassæ has reduced the amount of fat deposited, but these remedies are

by no means always effective for this purpose, nor should they be employed without real necessity and due care, for fear of inducing an anæmic condition: they probably act by bringing on a state of general malnutrition. In a case of *local* excessive deposit of fat round the neck of a girl, which was very unsightly and for which no available treatment could be at first suggested, the use of 15 to 20 min. doses of liquor potassæ thrice daily led to marked improvement, and so quickly as to be clearly traceable to the remedy (Lancet, i., 1873). In some other cases of fatty tumour liquor potassæ has also been given with supposed success as regards diminution of the growth, but this is not within my experience.

Diabetes.—The use of alkalies in this malady was at one time largely adopted in the hope that their property of assisting oxidation would be of direct service, but this hope has been in the main disappointed. The permanganate especially was recommended by Sampson (Lancet, i., 1853), and also by Ramskill (Med. Times, ii., 1867), but has not proved trustworthy (Bence Jones, Basham and others); it seems, however, to have the power of relieving the intense thirst of the malady. The compound alkaline waters of Vichy, Carlsbad, etc., ameliorate many cases. The nitrate, chlorate and tartrate are also serviceable in polydipsia, and are given dissolved in water or lemonade; the citrate in effervescence may give much temporary relief, and in ordinary form in ʒss to ʒi dose every hour it is strongly recommended by Dr. E. S. Reynolds for diabetic coma (Med. Chron., 1891). It has, however, disappointed me.

Albuminuria.—**Dropsy.**—The use of alkaline diuretics is advantageous in the early stages of this malady, the citrate of potassium or the acetate being the most suitable: they are presumed to act directly on the kidney, washing away débris and epithelium, which obstruct the tubules. In later stages when dropsy is present, and indeed in all forms of dropsy, 20 gr. doses of the acetate, or half that quantity of nitrate, given in conjunction with digitalis, squill, or other vegetable diuretics, often secure a copious secretion from the kidneys. The phosphate has recently been recommended.

Habitual Abortion.—Sir James Simpson long ago (Edin. Med. Journ., 1866) recommended chlorate in this condition, which

he traced to degenerated placenta in non-syphilitic cases, and Dr. R. Jardine has recently brought forward evidence in its favour. Ten grain doses thrice daily from the third or fifth month were sufficient to ensure a full-time pregnancy and a healthy child in women who had aborted several times at the seventh month (B. M. J., ii., 1902). He notes the absence of any unfavourable blood change from these doses.

Blood Poisoning.—Pyæmia.—The influence of potash upon oxidation and upon the condition of the blood has led to its employment in cases of absorption of poisonous material.

Savory has found it of distinct value, not in acute but in chronic pyæmia (Lancet, i., 1867), and Sir James Paget records the disappearance of a chronic pyæmic abscess under the use of liquor potassæ (Barth. Hosp. Rep., vol. i.).

Syphilis.—By those who decry or discourage the use of mercury in syphilis, the chlorate of potassium is much depended upon as a substitute, especially in infantile forms of the disorder (Drysedale, Dub. Press, Dec., 1862). It has been recommended as a prophylactic in cases of habitual abortion, possibly of syphilitic origin (*v. p.* 810). Although it may contribute to the healing of ulceration in this as in other cachexiæ, I cannot attribute to it special anti-syphilitic power. More has been claimed for the bichromate, and it seems to have proved sometimes useful, especially in ulcerated throat and in iritis; a pill containing $\frac{1}{10}$ to $\frac{1}{6}$ gr. with opium is the best way of giving it. In large doses it is an irritant poison, and its action as a remedy has not been well proved or extensively tried. I have myself been greatly disappointed with its effects in some obstinate cases of syphilitic disease.

PREPARATIONS AND DOSE.—*Potassii bromidum*: dose, 5 to 30 gr. *Potassii iodidum*: dose, 5 to 20 gr. *Liquor potassæ*: dose, 10 to 30 min., freely diluted. *Potassa caustica*. *Potassii carbonas*: dose, 5 to 20 gr., freely diluted. *Potassii bicarbonas*: dose, 5 to 30 gr. as an antacid, etc.; in acute rheumatism, 30 to 60 gr. every four hours, freely diluted with water. *Potassii acetas*: dose, 10 to 60 gr. as a diuretic; 120 gr. and upwards as a purgative. *Potassii citras*: dose, 10 to 40 gr. *Potassii tartras*: dose, 20 to 60 gr. as a diuretic and alterative; 120 gr. to $\frac{1}{2}$ oz. as a purgative. *Potassii tartras acidus*: dose, 20 to 60 gr. as a refrigerant or diuretic; 120 to 300 gr. as a hydragogue purgative (contained in confect. sulphuris). *Potassii sulphas*: dose, 20 to 120 gr. as a purgative; 10 to 40 gr. as an alterative. *Potassii nitras*: dose, 5 to 20 gr. as a refrigerant and diuretic;

20 to 30 gr. as a vascular sedative. *Potassii cobalto-nitris*: (not off.) dose, $\frac{1}{2}$ gr. as often as necessary or 4 gr. at one dose. *Potassii chloras*: dose, 5 to 15 gr. *Trochisci potassii chloratis*: 3 gr. in each lozenge. *Potassii permanganas*: dose, 1 to 3 gr. (v. p. 760). *Liquor potassii permanganatis* (contains 1 per cent.—dose, 2 to 4 fl. dr.; for external use, 1 fl. dr. to 5 or 10 oz. of water). *Potassii cyanidum* is used in the preparation of Bismuthum purificatum. *Potassii ferrocyanidum* is used for the preparation of hydrocyanic acid and of cyanide of potassium, in addition to being used as a test solution. *Potassii succinas (deliquescent)*: (not off.) dose, 5 to 10 gr. *Potassii telluras*: (not off.) dose, $\frac{1}{2}$ gr. in pill, once daily. *Potassa sulphurata*: dose, 2 to 8 gr. in pill (often used in much smaller doses in pill or in water— $\frac{1}{10}$ gr. or even less for children). *Unguentum potassæ sulphuratæ* (not off.) (should be recently prepared). *Sapo mollis*.

SODIUM—NATRIUM, Na = 23 (22·88).

This metal does not occur native, but in various combinations is found extensively throughout all the kingdoms of nature; the chloride especially is abundant in the animal organism, also in sea-water, in many mineral springs and marine plants, as well as in mineral formations. The nitrate of sodium (Chili saltpetre) occurs as an efflorescence on the soil in some countries.

CHARACTERS AND TESTS.—Sodium, the metallic base of soda and its compounds, is of waxy consistence, and silver-white colour. It has a great affinity for oxygen, and when placed upon water floats like potassium, producing effervescence from escape of hydrogen, and combining with the oxygen of the water to form soda; it is therefore necessary to keep it under mineral naphtha; the specific gravity is 0·972. Sodium is the only metal of which the ordinary salts are all soluble in water, and therefore do not furnish precipitation tests; we have, however, an excellent reaction in the flame-test, *i.e.*, the communication of an intensely yellow colour to a clear flame; so delicate is this test, and so universally diffused are the compounds of sodium, that it is difficult to obtain a flame perfectly free from all traces of them. The metal is used to make the following preparation.

LIQUOR SODII ETHYLATIS—SOLUTION OF SODIUM ETHYLATE.

CHARACTERS.—It is a colourless syrupy caustic liquid, becoming brown on keeping, of specific gravity 0·867. It contains 18 per cent. of ethylate of sodium (C_2H_5ONa) and when heated a white residue consisting of this salt remains, the alcohol having been all driven off. It should be freshly prepared for use.

COMPOUNDS OF SODIUM.

SODA CAUSTICA—*CAUSTIC SODA*—*SODIUM HYDRATE*
($\text{NaHO} = 40$). (*Not Official.*)

CHARACTERS.—It occurs in whitish cakes or pencils which are highly alkaline and corrosive; it is not so deliquescent as potash.

SODII CARBONAS—*SODIUM CARBONATE*—*SODA OR*
WASHING SODA ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} = 286$).

CHARACTERS.—It occurs in large rhombic crystals, colourless and transparent when fresh, but readily efflorescing on exposure to air; of nauseous alkaline taste, very soluble in water, not at all in alcohol; they contain 63 per cent. of water of crystallisation, which they lose at a sufficient heat. Twenty grains of carbonate of sodium neutralise 9·8 gr. of citric, and 10·5 of tartaric acid.

Sodii Carbonas exsiccatus, or dried sodium carbonate (Na_2CO_3), being the same salt deprived of water and powdered, is introduced as a separate preparation for convenience in dispensing; 1 gr. = about $2\frac{1}{2}$ gr. of the crystallised salt.

SODII BICARBONAS—*SODIUM BICARBONATE*
($\text{NaHCO}_3 = 84$).

CHARACTERS.—It occurs in small snow-white grains or scales, or in opaque white powder, slightly alkaline and somewhat unpleasant to the taste, permanent in the air, and soluble in water. Good commercial bicarbonate commonly contains 2 or 3 per cent. of carbonate. Twenty grains of the former salt neutralise 16·7 gr. of citric and 17·8 of tartaric acid.

Sodii Arsenas (*v. Arsenic*). *Sodii Bromidum* (*v. Bromine*).

Sodii Iodidum (*v. Iodine*). *Sodii Salicylas* (*v. Salicin*).

SODII BENZOAS—*SODIUM BENZOATE* ($\text{C}_6\text{H}_5\text{COONa} = 144$).

CHARACTERS AND TESTS.—A white, obscurely crystalline or amorphous powder, without smell or with faint benzoic odour, of sweetish taste and slightly alkaline reaction; very soluble in water and in spirit. When heated it melts, emitting a faint benzoic odour, and then chars. An aqueous solution gives a yellowish or flesh-coloured precipitate with solution of persulphate of iron.

SODII BIBORAS—*SODIUM BIBORATE OR PYROBORATE*—
BORAX ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O} = 382$).

CHARACTERS.—It occurs in flattened semi-transparent prisms, of slightly alkaline reaction and saline taste, soluble in water, and efflorescing in

the air. Its solubility is increased by glycerin and by cream of tartar, and from its solutions boric acid is precipitated by any mineral acid; it gives a green colour to flame. When heated it dissolves in its water of crystallisation, and at red heat forms a transparent glass much used as a flux for mineral substances in blow-pipe operations.

LIQUOR SODÆ CHLORINATÆ—SOLUTION OF CHLORINATED SODA.

CHARACTERS.—A colourless alkaline liquid, with the odour of chlorine, and a pungent taste; its specific gravity is 1·054; it bleaches vegetable colours, effervesces with acids, and readily evolves chlorine.

*SODII CHLORIDUM—SODIUM CHLORIDE—COMMON SALT,
(PURIFIED) ($\text{NaCl} = 58\cdot5$).*

CHARACTERS.—It occurs in transparent cubes or small white grains, soluble in water, and, if pure, permanent in air; deliquescent if containing chloride of calcium or magnesium.

*SODII CITRO-TARTRAS EFFERVESCENS—EFFERVESCENT
SODIUM CITRO-TARTRATE.*

*SODII HYPOPHOSPHIS—SODIUM HYPOPHOSPHITE
($\text{NaPH}_2\text{O}_2 = 88$).*

CHARACTERS.—A white, crystalline, bitter salt, deliquescent, and very soluble in water and spirit. It readily decomposes so that explosions occur with it on mixture, for instance, with chlorate of potash, and friction; when heated to redness it ignites, and gives off phosphuretted hydrogen.

SODII NITRIS—SODIUM NITRITE ($\text{NaNO}_2 = 69$).

A white, deliquescent crystalline powder, which slowly oxidises to the nitrate when exposed to air. It is not very soluble in alcohol, and is decomposed by weak acids.

*SODII PHOSPHAS—SODIUM PHOSPHATE—HYDROGEN
DISODIUM PHOSPHATE ($\text{Na}_2\text{HPO}_4\cdot 12\text{H}_2\text{O} = 358$).*

CHARACTERS.—It occurs in large, transparent, rhombic prisms, which quickly effloresce in the air; they are faintly alkaline, very soluble in water, and have a mild saline taste.

*SODII PHOSPHAS EFFERVESCENS—EFFERVESCENT
SODIUM PHOSPHATE.*

SODII SULPHAS—SODIUM SULPHATE—GLAUBERS' SALT
($\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} = 322$).

CHARACTERS.—It occurs in transparent, colourless, six-sided prisms, which are deeply channelled; they are efflorescent in the air, and have a saline bitter taste and neutral reaction. Arsenic is a frequent impurity.

*SODII SULPHAS EFFERVESCENS—EFFERVESCENT
SODIUM SULPHATE.*

SODII SULPHIS—SODIUM SULPHITE
($\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O} = 251.56$).

CHARACTERS.—It occurs in colourless, transparent, monoclinic prisms, efflorescent in dry air; it is inodorous and has a cooling, saline and sulphurous taste. It is readily soluble in water and spirit. The aqueous solution has a neutral or faintly alkaline reaction, and if treated with hydrochloric acid evolves sulphurous acid.

*SODA TARTARATA—TARTARATED SODA—TARTRATE OF
SODIUM AND POTASSIUM—ROCHELLE SALT*
($(\text{CHOH})_2\text{COONa} \cdot \text{COOK}, 4\text{H}_2\text{O} = 282$).

CHARACTERS.—It occurs in large, colourless, rhombic prisms or halves of prisms, which have been compared to tombstones; they are neutral in reaction, soluble in water, and of saline rather bitter taste.

Pulvis sodæ tartaratæ effervescens—Effervescent tartarated soda powder—Seidlitz powder.

SODII SULPHOCARBOLAS—SODIUM SULPHOCARBOLATE
($\text{C}_6\text{H}_4\text{OH} \cdot \text{SO}_2\text{ONa}, 2\text{H}_2\text{O} = 200$).

CHARACTERS.—It occurs in colourless, transparent, rhombic prisms, nearly inodorous, with a cooling saline and somewhat bitter taste. It is readily soluble in water, the solution being neutral to litmus. On ignition it gives off carbolic acid.

Other compounds of sodium used medicinally but which are not official are the following: *Sodii Cacodylas*: *Sodii chloras*: *Sodii cinnamas (Hetol)*: *Sodii citras*: *Sodii Hippuras*: *Sodii sulpho-Ichthyolas*: *Sodii Sulphovinas*—*Tauro-Cholas*—*Telluras*.

ABSORPTION AND ELIMINATION.—The salts of sodium, though highly diffusible, are not so much so, nor so readily absorbed as those of potassium. Small doses become changed in the stomach into chloride, but large quantities undergo this change only in part, the rest being absorbed unchanged; from the rectum also, sodium salts are absorbed without chemical decomposition. In the blood they circulate as chlorides, carbonates, phosphates, etc., and are eliminated mainly by the urine: the carbonates, nitrates, and other salts of *mineral* acids in their natural state, but citrates and other salts of *vegetable* acids pass out as carbonates. The nitrite is quickly absorbed, and the greater part of it excreted by the kidney as nitrate, but some passes unchanged; it may be detected also in the saliva and perspiration.

The time that elapses between absorption and some elimination is not precisely known but is short, for the nitrate and an excess of chloride have been found in the saliva and urine within a few minutes after the taking of those salts; also a very large quantity (60 grammes) of nitrate has been taken in divided doses during a day without injury, whilst half the amount in *one* dose has proved poisonous.

The chloride is never completely eliminated from the system even if it be excluded from the diet; on the other hand, if an excessive quantity be taken most of it is rapidly got rid of; thus Lehmann analysing his blood before and during the action of a salt-dose or salted diet, found the proportion of salt in the blood to be very similar, the excess being passed out by the kidneys almost as soon as taken. Dr. Herringham has recently published cases of renal disease in which elimination of sodium salts was completely arrested; this occurred especially in fatal cases (B. M. J., i., 1903).

Chloride of sodium in the air or in the form of a finely divided spray is absorbed from the pulmonary mucous membrane even more quickly than from the stomach. It is not absorbed through the unbroken skin. Sodium salts like alkalies generally are eliminated to a slight extent by the mucous membranes, especially by those of the respiratory tract, the secretion of which they tend to increase and make thinner; they exercise a remarkably stimulant effect upon the vibratile movements of ciliated epithelium, which they revivify after apparent extinction.

PHYSIOLOGICAL ACTION.—*External.*—The *hydrate* of sodium exerts a local caustic effect, consequent upon its great affinity for water and its power of dissolving nitrogenous tissues. The *carbonate*, applied in solution, dissolves sebaceous and fatty secretions, and if concentrated acts as an irritant. Solutions of *chloride* redden and stimulate the skin, and if applied to a surface denuded of epithelium excite much smarting and flow of lymph; redness is then masked by whitish opacity of the albuminous secretion, and the same whitish appearance may be observed on the inner aspect of the buccal mucous membrane after eating much salted food. Strong saline baths may cause cutaneous eruptions.

Salt has a direct local stimulant or irritant effect on nervous tissue, and for some physiological experiments C. Bernard considered it more effective than galvanism. If the exposed sciatic nerve of a frog be dipped in salt and water, immediate spasmodic contraction of muscles occurs in the limb; if the tympanic nerve be so treated saliva is secreted. This however is no special property of sodium chloride; most strong chemical reagents behave in a similar way, but salt is a convenient substance to use in order to demonstrate that nervous impulses can be set going by chemical stimuli.

PHYSIOLOGICAL ACTION.—*Internal.*—**Oxidation and Nutrition.**—Under potassium has been summarised evidence as to the action of alkalis on oxidation, and with regard to the carbonates of sodium we may equally conclude that whilst large and continued doses induce anæmia and asthenia, small quantities given for a moderate time help to saponify fatty food, to aid its oxidation and that of carbonaceous material generally, to improve digestion, and to raise temperature. This is especially the case with the chloride of sodium, and indeed Rabuteau teaches that it is by conversion into this salt that the other sodium compounds produce the good effects mentioned. Confirming conclusions already published by Voit (Brit. and For. Rev., ii., 1862), he showed that the chloride increases “vital combustion,” for whilst taking an extra daily dose of 10 grammes of salt, his excretion of urea was 20 per cent. more, and his temperature was half a degree higher, than when under a dietary from which salt was excluded. Similarly Kaupp found that when taking 1 gramme

of salt the amount of urea excreted was increased 4 centigrammes, the other soluble constituents of the urine being diminished. According to Zabelin, salt favours absorption of phosphates specially, and rather hinders their excretion, which effect would to some extent favour nutrition. Falck found also increased excretion of urea after giving salt to fasting animals (1872), whilst Münch reported from large doses, continued for a few days, at first diminished excretion and gain in weight, afterwards a contrary effect. Hyadis and Damoceretté also report increase in elimination of urea and uric acid under sodium salts, and Haig maintains that alkalies clear out urates from other organs to pass them through the circulation to the kidney.

On the other hand, Stadelmann, after a careful series of observations with carbonate, bicarbonate and citrate of sodium, concluded that the excretion of ammonia and uric acid was lessened; that of urea also was so at first and afterwards varied daily, but on an average did not differ much from normal, while the amount of nitrogen in the fæces was nearly doubled. The experimenters were in a condition of nitrogenous balance, that is, on fixed diet with a constant excretion of nitrogen, before commencing to take the drugs, which were given in both large and small doses,—the citrate was taken better than the other salts, and to the extent of 20 oz. without injury to primary digestion—which would itself have affected metabolism (B. M. J., i., 1890). His and Levy also found no marked effect on the uric acid.

Again another set of observers—Mayer, Ott, Clar, Klimptnir and perhaps the majority—report the carbonate to *diminish* the excretion of uric acid, and I think the balance of evidence so far is on their side. Salkowski found a diminution in man because less was formed, but an increase in dogs (Therap. Gaz., 1890). Rabuteau found that 5 grammes daily of bicarbonate lessened the urea excreted and at the same time impaired the blood condition (v. p. 789). Jovitzo reported the same of the nitrate and sulphate—Pugliese states that the chloride in doses of 0.23 to 0.5 gramme per kilogramme of weight, also lowered the excretion of urea in dogs and limited nitrogenous metabolism in man: it only increased the excretion of chloride and of potassium salts in the former: it raised their digestive coefficient of proteids, and they gained in weight (Archiv. Ital. de Biol.,

Turin, 1896, xxv.). Certainly, as a rule, nutrition of men and animals improves under a ration of salt, and suffering follows its deprivation, as in the American War of Independence and during the siege of Metz. Barbier records that certain Russian serfs, deprived for a time of salt (from motives of economy), suffered so much (becoming albuminuric and dropsical) that their lords were forced to supply them with it again (*Gaz. Méd.*, 1838). On the other hand, it is curious that the Tlascalans are said to have lived for half a century without salt (Prescott), and certain Aryan tribes never use it (Fick), or else their ordinary food contains sufficient to supply the needs of the economy; it may be added that advocates of the "Nature Cure," and certain special dietary systems, trace more harm than good to the ordinary use of salt, owing to supposed interference with osmosis, and causation of thirst and drinking too much fluid.

Whether the sodium chloride contained in our food is sufficient or whether additional small quantities should be used, as is our custom, has been a much discussed question. Bunge says that purely herbivorous animals require salt, while the carnivorous do not; mixed eaters require a small amount. The fact is well known that wild herbivora travel long distances to procure it, while carnivora never touch it and dislike salted meats. Bunge's explanation of these facts is, that in the food of herbivora potassium salts are from two to four times more abundant than sodium salts. If potassium phosphate for instance be absorbed into the blood it decomposes the sodium chloride there, and potassium chloride and sodium phosphate are formed. Both of these salts being foreign to the blood are soon excreted, and more sodium chloride must be taken to make up the loss. In the food of carnivora, however, there is no excess of potassium salts, and thus the sodium chloride of the blood remains uninterfered with. Mixed eaters therefore, such as man, require a small amount of salt as an addition to their dietary, but certain tribes which live entirely on flesh are in the position of carnivorous animals with regard to the consumption of salt.

We must repeat that the above-mentioned good effects of ordinary salt and of alkaline compounds are obtained only within certain limits of dose—an excess causes not only thirst and disordered digestion, but an impaired condition of the blood, and of nutrition.

Digestive System.—What has been stated under potassium as to the influence of alkalies upon digestion and secretion applies equally to the alkaline salts of sodium, but the chloride of sodium has a special value, because it furnishes in part the gastric acid; it aids the solution of albuminous substances and increases the amount of saliva and gastric juice. Bardeleben proved this by observations on dogs with gastric fistula, though, indeed, many other salts and even mechanical irritants will provoke a temporary increase in the gastric secretion. Rabuteau found that salted diet increased also the degree of its acidity. Observations on the gastric juice of dogs fed on meat washed free from chloride showed that not only did the chlorides disappear from the urine, but also hydrochloric acid from the gastric juice. If chlorides were then administered, an abundant secretion of hydrochloric acid began almost immediately (Cahn, *Zeitsch. physiol. Chem.*, x.). The question has arisen how the chlorides give rise to a secretion of free hydrochloric acid, and there seems to be no doubt that although the salt may act in some measure as a simple stimulant, it is chiefly by means of a chemical reaction that the formation of free acid takes place. Landwehr has advanced the theory, that lactic acid is formed by fermentation from the mucus of the stomach, and reacting on the sodium chloride liberates its free acid (*Chem. Centralblatt*, 1886). This reaction certainly occurs in experiments performed outside the body, but it will not account for the formation of the acid in all cases, for often no lactic acid is discoverable; and E. Frerichs has demonstrated that in fifteen minutes after the introduction of distilled water into the stomach of men and dogs traces of hydrochloric acid are discoverable (*Biol. Centralb.*, 1886). (This does not agree with the observations of van der Velden that the acid is not perceptible until one and a half to two hours after a meal.) Maly suggests that as free hydrochloric acid is formed outside the body as the result of a reaction between sodium or calcium chloride, sodium dihydrogen phosphate and disodium hydrogen phosphate (phosphates of soda), a similar reaction between these salts in the blood may also occur (*Sitzungsber. k. Akad. d. Wissensch.*, Bd. 76). In connection with this question it is interesting to note that E. Kulz (*Zeitschr. Biol.*, Bd. 23) has found that after the administration of iodides and bromides, free hydriodic

and hydrobromic acids respectively are formed in the gastric juice. The researches of Jaworski, du Mesnil, Lemoine and Linossier, Gilbert and Modiano and others on the influence of sodium bicarbonate on the gastric secretion, show that *immediately* after its ingestion it produces an increase in the amount and then partial or complete neutralisation of the acidity; if the dose be sufficiently large the alkalinity which supervenes arrests peptic digestion. With a small dose the secretion of hydrochloric acid continues after all the bicarbonate has been transformed into sodium chloride, or is even more active than before. When it is given before meals it stimulates both the motor functions of the stomach and its secretion, especially in cases of diminished acidity. According to Reichman, however, its principal beneficial action depends on its power of removing the gastric mucus. The *remote* effect of the administration of sodium bicarbonate on the gastric juice, as Linossier and Lemoine and others have pointed out, is to reduce its secretion, presumably by alkalisisation of the blood (Bul. Gén. de Thérap., 1894, vol. cxxvii.).

The good effects of sodium chloride are shown clinically by small doses of 15 to 60 gr. Large quantities precipitate proteids of the globulin class, whilst very large and concentrated doses cause vomiting, watery purging, and even gastritis; in China they are said to be used for suicidal purposes. Injection of much salt into the crural vein of dogs causes ptialism, intestinal gurgling, and temporary lessening of the size of the spleen (Podkaepow).

The action on secretion of bile is not certainly known; Nasse, experimenting with animals, found it lessened, and Stadelmann reported that moderate doses of alkaline salts neither increased the total amount, nor that of colouring matters, acids or fats in it. Large doses even lessened the total amount (probably by removing fluid from the system) but left the biliary constituents unaltered (*v. p.* 819), but observations made after the use of alkaline waters show an increase (Grossmann), and this would be in accord with analogy. Rutherford has stated that sulphate of sodium has marked cholagogue properties, but the good effects of alkalis in so-called bilious states are attributable rather to an influence on the catarrhal conditions than to any supposed influence on the secretion of bile. During their administration the bile becomes more alkaline and watery, and thus mucus and biliary constituents are

dissolved so that they more easily pass along the common bile duct. According to Dr. Pavy, the carbonate not only increases the bile but also the percentage of fat in the liver (Guy's Reports, 1861; Proc. Roy. Soc., vols. x.-xi.; Med. Times, i., 1865); also the glycosuria which commonly follows certain traumatic lesions of the sympathetic, does not occur if much soda be previously introduced into the blood; these are curious facts, of which we do not at present see the full bearing.

Circulatory System.—It is an important difference between potash and soda, that the former, under certain conditions, is an active cardiac depressant and poison, whilst the latter has little effect on the heart-muscle or the circulation. Frogs die, but only slowly, after the injection of large quantities (Podkaepow, Guttman), whilst upwards of 100 gr. of sodium carbonate have been introduced into the vein of a dog with but slight and temporary malaise and muscular weakness (Grandeau, Robin's Journ., 1864). These differences are only observable when the different alkalies are *injected* directly into the blood. If given by the stomach, as stated (*v. p.* 793), potassium seems to exert no very depressant effect in man, possibly because it is rapidly excreted and only a small amount is present in the circulation at any one time. Sodium is, like the other alkalies, a cardiac poison, though to a less extent than potassium and ammonium; the contractility of the heart is chiefly affected, the excitability being but little influenced. A small amount of sodium chloride is necessary in a saline fluid used to keep a heart beating, but unless it is mixed with traces of a potassium and a calcium salt the heart is soon brought to a standstill in systole (Pract., ii., 1883).

Whether the excessive use of highly salted food is the main cause of scorbutic conditions, such as occur in sailors, must be considered doubtful; they have been supposed to arise from the hardships of such life, from deficiency of *potash*, of vegetables, and also from the presence of ptomaines in the salted or imperfectly preserved foods (F. G. Jackson and V. Harley); but it would seem as if either great (relative) *excess* or *deficiency* of the salt or potash led to equally injurious consequences. Prussac found that when frogs were placed in concentrated salt solutions, or had them injected into the lymph sacs, copious "wandering" of red corpuscles took place from uninjured vessels, and

also capillary hæmorrhage. (This, however, like the action upon nerve, is not peculiar to sodium chloride,—almost any other chemical reagent will set up similar inflammatory conditions.)

Soda is more abundant in the blood plasma, whilst potash occurs most in the red corpuscles, and excessive doses of the former alkali may alter this normal relationship, and thus interfere with respiratory combustion and with nutrition. According to Swiatecki (*Zeitschr. f. Physiol. Chem.*, Nov., 1890), who made experiments on dogs, using sodium sulphate, the rise in the alkalinity of the blood brought about by this and other saline purgatives is due to the exosmosis of acids from the blood into the intestines.

The proportion of sodium chloride in normal blood has been variously estimated at from 3 to 5 per 1,000. It is diminished in various morbid states, such as cholera, diabetes (Nasse), jaundice, chlorosis; in pneumonia, on the contrary, and in some forms of renal disease (*v. p.* 816) its elimination is checked, and hence an excess remains in the blood.

Nervous and Muscular Systems.—There is some (not cogent) clinical evidence that excess of soda in the blood leads to convulsive action of the nervous system (Laycock, *Med. Times*, i., 1863; Hunt, *Med. Times*, 1856); most observers think an excess of little import. In large doses sodium salts lengthen the time of contraction of voluntary muscles, instead of shortening it like potassium salts. Their action on involuntary muscle is not so marked as that of potassium salts (*Pract.*, Jan., 1882). Dr. Ringer finds that the bicarbonate and the rhombic phosphate of sodium produce a prolongation of the muscle-curve, like veratrine. These salts also produce fibrillar twitchings in frogs' muscles very like those of progressive muscular atrophy. Such effects are produced after the section of nerves, and so they are not central.

Urinary System.—With regard to the influence of soda salts on diuresis opinions are divided, partly perhaps because of the different doses employed. Usually some increase in the quantity of urine is observed in patients taking carbonates, especially in those with acid dyspepsia, but it is not always the same with healthy persons. Münch found in five subjects, when perspiration or diarrhœa did not occur, *increased excretion of*

water as the principal effect of 3 to 6 or 9 gramme doses of carbonate, but Rabuteau and Constant could not verify any increase with 5 gramme doses given daily. A continued weak alkalescence of the urine may be secured from about 3 gramme doses of bicarbonate of sodium taken thrice daily at meal-times, whilst one daily dose of 5 grammes will give alkalinity for only two or three hours—even 1 gramme will do this if taken fasting. Much dilution or warmth of the liquid in which the drug is taken promotes the alkalescence of urine, and it lasts longer in weak or elderly persons.

The chloride will produce the same effect, though not so quickly as the carbonate, and under its use earthy phosphates replace free acids.

Glandular System.—Milk is secreted in increased quantity under the influence of salt. This fact, indicated by Saive but denied by Boussingault, was confirmed by Rabuteau. In Brazil and some other countries there is a popular custom of watering the food of milch cows with salt water to increase their milk, but the animals also may simply drink more, and thus secrete more watery milk. Large doses of borax (50 gr.) induce copious secretion of saliva, occasionally sickness and dyspepsia; and more rarely a scaly eruption on the skin.

SYNERGISTS.—The chemical action of the alkaline salts of sodium is shared by other alkalies, the physiological action of the chloride of sodium by other chlorides; as a *digestive* stimulant, condiments assist its power.

ANTAGONISTS. — INCOMPATIBLES. — Acids antagonise the chemical effects of alkaline salts of sodium, though the vegetable acids are often added to them to secure liberation of carbonic acid gas and formation of neutral salts. Mucilaginous substances lessen the local irritant effects of excessive doses of chloride or nitrate, and the chloride itself is a suitable antidote for nitrate of silver.

Sulphate of sodium acts as an antidote to carbolic acid by forming the almost innocuous sulpho-carbolate of sodium in the blood; in cases of poisoning 2 or 3 dr. dissolved in warm water should be given by the mouth at intervals. Sulphates do not *directly* antagonise carbolic acid, but so long as they are present in the blood in sufficient amount the acid forms with them sulpho-carbolates (of sodium, potassium, etc.), which are

very slightly toxic; as soon as the sulphates are exhausted the carbolic acid circulates free and is highly toxic.

THERAPEUTICAL ACTION. — *External.* — **Strumous Ulceration, etc.**—For destroying unhealthy growths, the edges of strumous ulceration, etc., caustic soda has been sometimes used. It is less deliquescent than potash, but yet it is very diffusible, and readily extends its action; it therefore requires the precaution of protecting adjacent parts, and of neutralising with weak vinegar or oil after application.

Glandular Scrofulosis.—A strong solution of salt locally applied is a good resolvent of enlarged and hard glands; sea-bathing is useful for the same purpose.

Frictions with a pomade containing salt cause a pustular eruption, and have been used over the chest in phthisis (Med. Times, ii., 1859).

Hoarseness.—**Catarrh.**—A piece of borax allowed to dissolve slowly in the mouth sometimes cures these conditions. A spray containing salt (gr. iv-v ad 3j) is also useful.

A simple mode of stimulating the external surface in some chronic catarrhs and relaxed throat conditions is sponging or bathing of the neck and chest in salt water night and morning, and following this with friction.

Unhealthy Wounds.—Solution of chlorinated soda mixed with water in various strengths makes an excellent detergent and disinfectant gargle, lotion, or injection, but is rather a preparation of chlorine than of soda.

Hæmorrhage.—Much evidence has recently accumulated as to the value of warm saline injections in conditions of collapse, especially when this is due to loss of blood or serous fluid whether in cholera, dysentery, operations, childbirth, etc.; it seems to replace in many cases transfusion of blood. The strength now used is less than formerly, about 1 dr. of salt to the pint of water (boiled) at 100° F. = $\frac{3}{4}$ per cent. During the recent epidemic at Hamburg such intravenous injection was part of the routine treatment of severe cases, and often with good effect, but in non-choleraic cases it has many times seemed to save life by stimulating the circulation, and this as well by injection into the bowel, or even the peritoneal cavity, or the cellular tissue, as into the vein (Lancet, B. M. J., 1891, 2-3). We cannot suppose that the salt is

a very active agent in the good result—it simply supplies one constituent of the normal circulating fluid ; a more scientific substitute is in the formula known as that of Jennings, *viz.*, sodium chloride, 50 gr. ; sodium sulphate and carbonate, of each $2\frac{1}{2}$ gr. ; sodium phosphate, 2 gr. ; potassium chloride, 3 gr. ; dissolve in a pint of hot water (sterilised), and at 100° F. add of absolute alcohol 2 dr.

Pruritus.—Eczema, etc.—In several forms of skin disease attended with itching, lotions containing a small proportion of carbonate or bi-borate of sodium, 1 to 2 dr. in $\frac{1}{2}$ pint, are often serviceable. In *urticaria*, *lichen*, and the early inflammatory stages of eczema when alkaline oozing occurs, the same lotion will give relief, but in the last case it should be made weaker still—20 to 30 gr. in the $\frac{1}{2}$ pint ; or again, 20 gr. of the carbonate of sodium may be usefully combined with an ounce of zinc ointment ; for *urticaria* salt has also been prescribed internally (Lancet, i., 1897). In several forms of papular and scaly eruptions, such as *lichen* and *psoriasis*, baths containing about 4 to 6 oz. of carbonate of sodium are very useful, being sedative as well as detergent. For common *chilblains* a strong solution of salt in water is a good domestic remedy ; borax with glycerin is also good.

A weak lotion of borax is also often useful in cases of ordinary *sore nipple* ; Sir Astley Cooper commonly prescribed it with spirit of wine. For slight cases of fissured *sore tongue* or buccal irritation the glycerin of borax is pleasant and efficient.

Tinea Versicolor and even mild cases of *tinea tonsurans* may be cured by the same remedy, also sometimes by strong salt solution. For the irritation and scaling connected with so-called *pityriasis capitis* a lotion containing borax, camphor and rosemary is a good application.

Aphthæ, etc.—Aphthous conditions affecting the mouth and fauces are often treated with borax mixed with honey or dissolved in glycerin ; a solution of chloride will also succeed sometimes. Aphthous conditions affecting the vulva and the very irritating “*pruritus pudendi*” in either sex may be much relieved by warm lotions or by paints containing borax. The chlorate of sodium is equal if not superior to the chlorate of potassium in these cases and in ulcerations : a tablet is made containing it with borax (Martindale).

Tonsillitis.—Dr. Armangué has reported a large number of cases of tonsillitis cured within twenty-four hours by the local application of the bicarbonate of sodium (*L'Union Médicale de Canada*, Dec., 1881). Dr. Giné states that the predisposition to this disease is also thereby lessened—a statement which has been confirmed by others (*Lancet*, i., 1884). Borax is in frequent use with us in the same condition (*v. Int. Action*). To relieve discomfort from the collection of tenacious mucus at the back of the throat in quinsy a hot saturated solution of sodium bicarbonate is very efficacious as a gargle.

Acne Simplex.—A liberal use of soap with hot water is often necessary in this disorder, and a borax lotion or spirituous solution is of service.

Burns.—In burns and scalds, especially of the first degree, a saturated solution of the bicarbonate applied constantly on moistened cloth quickly relieves the burning pain.

Dental Caries.—Toothache connected with open carious teeth may be relieved by the local use of carbonate of sodium ($\frac{1}{2}$ dr. in the ounce of warm water).

Rheumatism.—**Gout.**—Soda baths are also useful in relieving pains of rheumatic character in the joints and muscles. Basham recommended basic phosphate of sodium in powder as a good application for enlarged and painful gouty joints (*Med. Times*, ii., 1848), and it has some advantage over liquid applications; it may be applied on moistened spongio-piline. Hot salt in flannel is often a convenient mode of applying warmth to rheumatic or painful parts; in similar cases Dr. H. Bennett used “soda poultices” (*Times*, ii., 1853). Mr. J. Hutchinson finds no remedy so effectual in removing irritation and synovial effusion in rheumatoid arthritis, as compresses of a saturated solution of common salt applied to the affected joints, and kept on the whole night, and I have seen some advantage from it.

Leucorrhœa.—**Cystitis.**—Injections containing carbonate of sodium (1 to 2 dr. in the pint) form a simple and often efficacious remedy in cases of vaginal leucorrhœa with white alkaline discharge, and in chronic cystitis an injection of borax, glycerin and warm water is very soothing. The silicate of sodium has been lately recommended for the same purpose; it coagulates albuminous material and is antiseptic (*Ranking*, i., 1873). Sodium fluoride

in $\frac{1}{2}$ to 1 per cent. solution has been recommended as a local antiseptic in cystitis and vaginitis, and also as a mouth wash.

Ascarides, etc.—A strong injection of salt into the rectum is a popular cure for these parasites, and is best given with quassia or other bitter. (Rectal injections are however of little use in those numerous cases in which the cæcum is the habitat of the worms.) Salt is also taken internally to prevent recurrence of thread or round worms, and so strong at one time was the belief in its efficacy that an ancient law in Holland deprived certain criminals of salt in their diet, in order to allow intestinal worms to develop and devour the victims!

Leeches are very sensitive to the action of salt; it will make them disgorge blood they have swallowed, and a saline injection will dislodge them from the rectum or vagina. It is advisable to administer the same remedy freely should they by accident have passed from the nose or mouth to the stomach.

THERAPEUTICAL ACTION. — *Internal.* — Comparing sodium with potassium we find the former more indicated in disorders of the stomach, the primæ viæ, and the liver.

Dyspepsia.—Sodium salts are very useful in several forms of indigestion, but the dose and mode of administration vary somewhat according to the conditions present. In cases of *atonic* dyspepsia connected with deficient secretion of gastric juice the bicarbonate in small doses of 5 to 10 gr. should be given and shortly *before* a meal, on the principle already alluded to, *viz.*, that an alkali causes increase of an acid secretion, for though on first contact it neutralises the acid it meets with, additional acid is very quickly poured out so as to leave an excess. The alkali may in some cases be very suitably combined with an aromatic as in “Gregory’s powder,” with ginger only, or with a bitter, like tincture of orange or infusion of gentian. On the other hand, in cases of *acid* dyspepsia, with thickly coated or red shining tongue, sour eructations, heartburn and flatulence, larger doses of the bicarbonate (15 to 20 gr.) should be given an hour or more *after* a meal, according to the time at which the symptoms come on; in this case also the remedy may be well combined with an aromatic or stimulant, as ammonia or peppermint. Soda is especially useful for the dyspepsia of those who live in towns, eating and drinking freely, and taking little exercise. If the urine

be scanty and irritating, nitre may be given at the same time, and, according to Dr. Budd, an occasional blue pill. The taurocholate of sodium, which may be obtained in powder form from bile, has been found useful in the dyspepsia of gouty and "bilious" subjects; 2 to 5 gr. are given in pill, which should be coated with keratin. A dry skin and very furred tongue are other indications for soda, whilst for those who live in the country, take more vegetable food, and perspire freely, acids usually agree better (*Med. Times*, i., 1854). Linossier maintains that large doses of sodium bicarbonate have an analgesic effect in those cases where there is pain towards the end of digestion, and a diminution in the amount of hydrochloric acid present. He prefers to give it just before the time at which the habitual pains are expected to occur, and in doses of 50 cg. to 2 gms. (8 to 31 gr.), preferably in a very hot fluid, the stimulating effect on the movements of the stomach helping the action of the salt (*Bullet. Médical*, 1894, No. 24).

The familiar use of salt is of no small importance in stimulating appetite and digestion. Dr. Symonds states that "duodenal dyspepsia" with its attendant "bilious headache" may often be obviated for a long period by the daily taking of a tumblerful of "salt and water" before breakfast (*Med. Times*, i., 1858). An effervescent mixture containing sodium carbonate or sulphate is often efficacious in such headaches, and the whole class of common salt and alkaline waters are used mainly for dyspeptic and allied conditions.

Dilatation of the Stomach.—This is often satisfactorily treated by irrigation (lavage or syphonage) with dilute solutions of sodium bicarbonate, or biborate $\mathfrak{z}\text{i}$ to $\mathfrak{z}\text{iii}$ in the pint. The good results obtained probably depend on the removal of the gastric mucus which accumulates, in which the fermentative elements find lodgment.

In **Vomiting** or **Diarrhœa** connected with acidity or with incomplete digestion of fatty food, the bicarbonate of sodium with an aromatic such as cinnamon is very good. In children with coated, irritable or aphthous tongue, it may be combined with a little grey powder, and for adults, especially if colic is present, it may be given in effervescence with opium. In cases of dyspepsia, etc., in weakly subjects, the use of alkalies must not be too long continued.

Tonsillitis.—As a preventive in the epidemic form of follicular

tonsillitis the internal use of sodium benzoate has been recommended (Maxson, Jour. of Pract. Med., Dec., 1896; v. Ext. Action).

Hepatic Disorders.—For congestion of the liver with deficient excretion of bile, soda is of proved value in several combinations, and it relieves such symptoms as have been already described under dyspepsia.

Phosphate of sodium especially is said to promote the flow of bile, and acting in full doses as a gentle laxative it is useful in "bilious or sick headache," and in catarrhal jaundice. It has some value also in preventing biliary calculus, which condition arises generally from continued catarrh of the bile-duct and inspissation of mucus and bile. (Vichy water presents a good natural combination for such cases, and for chronic hepatic congestion.) The salt cannot be expected to control fully developed attacks of biliary colic, but if a dose of 20 or 30 gr. be taken regularly before meals for some months, it seems to have the power of lessening the calculi, or preventing fresh formations; from larger doses (1 to 2 dr.) of the carbonate in copious draughts of hot water Dr. Prout has often seen immediate relief even during the attack of colic. The salicylate is still more effective in 10 to 15 gr. doses two or three times daily: the same may be said of the oleate of sodium, a pure form of which is known as Eunateol (Therapist., Aug., 1899).

In *fatty degeneration of the liver* we have the authority of Dr. Murchison for saying that large quantities of common salt eaten with the food have proved useful, and there is at least encouragement to try saline waters in this condition. In the case of ill-conditioned children passing pale and pasty stools 5 or 10 gr. of the phosphate taken with meals will often serve to regulate digestion and improve nutrition (Stephenson).

Renal Diseases.—In cases of calculous (uric acid) diathesis, if it be desired to keep the system under the continued influence of alkalies, the salts of sodium have sometimes been preferred in weakly dyspeptic subjects, being less depressing than those of potassium commonly used. The waters of Vichy have a special reputation in such conditions, and under their influence a urate of sodium partly replaces uric acid in the urine, and is more readily eliminated. The phosphate was especially commended by Liebig and by Golding Bird as a solvent of lithic deposit.

Gout.—Although it is true that Vichy water relieves some

symptoms of gout, there is evidence that in many cases salts of soda act unfavourably. The theoretical explanation is that normally uric acid circulates as a quadri-urate which is readily eliminated, but under certain conditions and in presence of an extra amount of sodium carbonate an additional atom of the base is taken up, the less soluble bi-urate is formed, and ultimately precipitated in joints and elsewhere (Roberts, Luff). Tunnicliffe has controverted this (*Lancet*, i., 1900). Roberts goes so far as to forbid or restrict the use of sodium chloride in the gouty, and advises the potassium salt instead.

In **Albuminuria** it has been recommended to supply alkalies freely to the blood, in order to lessen the liability to inflammation, and to dissolve fibrinous deposits. It has been taught also that they further the oxidation which is deficient in this dyscrasia, but they can only do so in a slight degree. Soda, like other alkalies, may be occasionally useful in relieving the dyspeptic symptoms, but is no cure for albuminuria, and its prolonged use is contra-indicated by the tendency to anæmia.

Diabetes.—Speaking not of the temporary and accidental passage of sugar into the urine, but of diabetes mellitus, it is stated that small doses of bicarbonate or of chloride of sodium often lessen the amount of sugar passed (Clarke of New York and others).

At Vichy and similar springs it is found that stout diabetics derive advantage from the waters, when thin and pale patients do not. Transitory cases such as have arisen from temporary nervous causes, from carbuncle, etc., often do well at Vichy, and even old-standing cases have been relieved, but those with marked lesion of the pancreas or the pulmonary or digestive organs are not suitable for this treatment.

Ebstein reports favourably of Carlsbad and other alkaline waters, especially for mild cases (*Med. Times*, i., 1875), as also does Kraus (*Monograph on Carlsbad*, 1891). According to the theory of Mialhe they should help to oxidise sugar in the system, but their use cannot be based on this hypothesis. Poggiale fed dogs with non-nitrogenous food—starch and sugar—to which he added enough soda to render the urine alkaline, but their blood contained as much glucose as that of dogs fed without any soda; also he injected glucose into the blood of rabbits, and again injected it mixed with soda, in each case finding sugar in the

urine, whilst under tartaric acid the sugar disappeared (Bull. de l'Acad., 1886). Bouchardat, on the other hand, points out that alkalies may act dangerously in increasing the fluidity of the blood, and the tendency to apoplexy or pulmonary congestion, and Rabuteau cites several cases that died soon after commencing Vichy treatment. He suggests that whatever benefit is derived from sodium salts is really due to the chloride, and according to Nasse and others this salt is deficient in the blood of diabetic patients. Martin Solon (Bull. Gén., 1842-43), Constant (Thèse, 1844), and Bouchardat have reported some clinical illustrations of the good effects of salt given as medicine to such subjects. More recently there has been evidence of the value of sodium salicylate.

Struma. — Some writers have insisted on the therapeutical virtues of salt in this disease. Durand Fardel reported instances of benefit, and Amédée Latour reduced its administration to a system; he gave it to well-fed goats, and then used the goats' saline milk largely in the diet of his patients; he employed also all hygienic means, and obtained good results (Union Méd., 1851-56; Brochure, 1857). Piétra Santa is another advocate for the systematic use of salt in phthisis, recommending a "syrupus natrii chlorati". Dr. Cotton, however, could not trace any definite effects from salt in his treatment at Brompton Hospital. The saline baths of Soden, in Nassau, have a reputation in similar cases, and in *obstinate bronchial catarrh* the waters of Ems, etc., are often prescribed with advantage: they may be given diluted with warm milk, especially in the early morning. The sodium tellurate in doses of $\frac{1}{3}$ to 1 gr. in twenty-four hours has been found of use in checking the night sweats of phthisis. It should be given on three successive days in order to produce a permanent effect; it has, however, the disadvantage of imparting a garlic-like odour to the breath (Joquet). Sodium cinnamate (Hetol), in 1 per cent. watery solution, has been given in doses of 1 to 2 minims with due precaution by intravenous injection, in cases of phthisis not too far advanced, and with some good results; it may be used every second day in gradually increasing doses; it causes leucytosis and is presumed to increase congestion round, and then cicatrization of tubercular foci (B. M. J., E., i., 1899; ii., 1900). I have myself seen advantage from the salt given hypodermically (*cf.* Lancet, ii., 1902).

Pleurisy.—In cases with extensive effusion where aspiration has been refused, absorption has occurred under the use of drachm doses of salt every four hours and restriction of fluid by the mouth, but it is a trying method of treatment.

Cholera.—The carbonate of sodium in solution has been used as a transfusion in cases of cholera, but the chloride has been more depended on.

A reasonable argument may be given for its employment, for a main fact in the disease is profuse discharge from the vessels of the intestinal tract into the alimentary canal; this by itself can determine the cyanosis, shrunk features, blood stasis, etc. It depends upon a change in the albuminous constituents of the blood, and is increased by desquamation of intestinal epithelium, whilst by saline injections the loss of fluid may be compensated. Both rectal and intravenous injections have been used.

For **Dysentery** the sulphate of sodium has been much commended by French and American writers: 1 dr. is given with $\frac{1}{5}$ gr. of morphine every two hours, until natural though loose evacuations occur; this treatment is said to control the malady in two or three days (Med. Record, 1872).

Constipation.—On the other hand sodium sulphate, when given in larger doses of $\frac{1}{4}$ to $\frac{1}{2}$ oz., is a useful saline purge in inflammatory conditions, and is an ingredient in several natural aperient waters: if given with sulphate of magnesium or acid tartrate of potassium, smaller doses (1 to 2 dr.) may be used. The phosphate of sodium acts in the same manner on the intestinal tract, and has a more decided diuretic action; it renders the urine alkaline. Tartarated soda is an ingredient in Seidlitz powders.

Epistaxis.—**Embolism.**—Common salt is an ordinary domestic remedy for bleeding at the nose, and even for hæmoptysis, and cases of the former are sometimes favourably influenced by it when given in drachm doses. Some attribute the benefit from salt in hæmorrhage to the nausea excited, but it is more likely that it results from a reflex contraction of vessels consequent on the irritation of gastric nerves. It has been stated that in *embolism* the collateral circulation becomes better established under the influence of an alkali (sodium carbonate) though the thrombus itself is not affected (Brit. For. Rev., ii., 1861).

Uterine Inertia.—Borax has some stimulating effect upon

the uterus, as shown by its increasing the contractions during labour; it has been used in lingering cases, generally combined with ergot and cinnamon. It has been given also in *amenorrhœa*, with or without aloes, and in *dysmenorrhœa* with belladonna, but is not in general use. Since this is the only sodium salt that acts upon the uterine system, it probably does so through the boracic acid.

Glaucoma.—Both sodium salicylate and sodium biborate have been found useful, when given internally, in relieving the pains of glaucoma (Trans. Amer. Ophthal. Soc., vol. vii., part 2).

Epilepsy.—Borax is an old remedy for this disorder, and still finds a useful place in its treatment, *e.g.*, 15 gr. thrice daily were effective in a case of four years' duration—the only drawbacks were some sickness if taken fasting, and some sleeplessness (B. M. J., ii., 1882).

Drs. Russell and Taylor report good results from borax, but find it apt to cause a scaly skin eruption (Lancet, i., 1890). Gowers has found borax useful in some cases of inveterate epilepsy in which bromide had no influence, and has given it in 15 to 30 gr. doses thrice daily for years, without any ill-effects beyond an occasional eruption like psoriasis (Diseases of the Nervous System; see also Therap. Gazette, 1890). I find 10 gr. doses as much as can usually be borne, and have seen much benefit from them, but dyspepsia sometimes follows.

Menopause Neuroses.—The same remedy has also been found useful in combating the neuroses of women, particularly those at the menopause.

PREPARATIONS AND DOSE.—*Soda caustica* (not off.). *Sodæ chlorinatæ liquor*: 10 to 20 m.; 2 to 6 dr. in 10 oz. of water as gargle, etc. *Sodii arsenas*: $\frac{1}{10}$ to $\frac{1}{10}$ gr. *Sodii arsenatis liquor*: 1 per cent.; 2 to 8 m. *Sodii benzoas*: 5 to 30 gr. or upwards (in spray, 5 per cent.). *Sodii biboras*: 5 to 20 gr. (*glycerinum boracis*—*mel boracis*, each about 1 in 6 by measure). *Boroglyceride* (not off.), made by treating 92 parts glycerin with 62 boric acid. *Sodii bicarbonas*: 5 to 30 gr. *Trochiscus sodii bicarbonatis*: 3 gr. in each. *Sodii bromidum*: 5 to 30 gr. and upwards. *Sodii carbonas*: 5 to 30 gr. *Ib. exsiccatus*: 3 to 10 gr. *Sodii cinnamas* (Hetol) (v. p. 833). *Sodii chloras* (not off.): 10 to 30 gr. *Sodii chloridum*: as emetic $\frac{1}{2}$ oz. or upwards. *Sodii citras* (not off.): 10 to 60 gr. *Sodii citro-tartras effervescens*: 60 to 120 gr. and upwards. *Sodii ethylatis liquor* (caustic). *Sodii hippuras* (not off.): 5 to 30 gr. *Sodii hypophosphis*: 3 to 10 gr. *Sodii hyposulphis* (*thiosulphas*) (not off.): 10 to 60 gr.; as lotion 1 in 10. *Sodii iodidum*: 5 to 20 gr. *Sodii nitris*: 1 to

2 gr. *Sodii permanganas* (not off.) (disinfectant, green in colour). *Sodii phosphas* : for repeated administration, dose $\bar{5}$ ss to $\bar{5}$ iii, for a single administration, $\frac{1}{4}$ to $\frac{1}{2}$ oz. *Sodii phosphas effervescens* : $\bar{5}$ i to $\bar{5}$ ii for repeated doses ; for a single administration, $\frac{1}{4}$ to $\frac{1}{2}$ oz. *Sodii salicylas* : 10 to 30 gr. (this combined with *Theobromin* = "Diuretin" : 15 gr.). *Sodii santonas* (not off.) : 5 to 10 gr. *Sodium silicate* ("soluble glass") (not off.). *Sodii sulphas* ("Glauber's salt") : $\frac{1}{4}$ to $\frac{1}{2}$ oz. *Sodii sulphas effervescens* : $\bar{5}$ i to $\bar{5}$ ii for repeated doses ; for a single dose, $\frac{1}{4}$ to $\frac{1}{2}$ oz. *Sodii sulphis* : 5 to 20 gr. *Sodii sulphocarbolas* : 5 to 15 gr. *Sodii sulphoichthyolas* (not off.) : 10 to 30 gr. *Sodii sulphovinas* (*sulphethylas*) (not off.) : $\frac{1}{4}$ to 1 oz. as aperient. *Soda tartarata* ("Rochelle salt") : 2 to 4 dr. *Soda tartarata effervescens* (Seidlitz powder) : 120 gr. with 40 gr. sodium bicarbonate in blue ; tartaric acid, 33 gr. in white paper. *Sodii taurocholas* (not off.) : 2 to 6 gr. *Sodii telluras* (not off.) : $\frac{1}{3}$ to $\frac{2}{3}$ gr. in pill. "Carlsbad salt," artificial, contains of dried sulphate of sodium, 44 parts ; bicarbonate, 36 ; chloride, 18 ; potassium sulphate, 2 ; mixed and finely powdered : dose, 20 to 60 gr. and upwards.

SODIUM NITRIS—SODIUM NITRITE

($\text{Na No}_2 = 69$).

As the action of this salt resembles that of other nitrites and organic nitrates, it is considered apart from the sodium compounds.

It is prepared by heating the nitrate of sodium (Na No_3), which parts with an atom of oxygen when so treated. It is quickly absorbed and is mostly excreted in the urine as nitrate, but some is found unchanged : traces may be detected in the saliva and perspiration.

PHYSIOLOGICAL ACTION.—Barth was the first to recognise that the poisonous effects of the nitrates of sodium and potassium, as occasionally observed, were due to admixture of these salts with the corresponding nitrites (*Toxicolog. Untersuch. ueber Chilisalpeter*, Inaug. Diss. Bonn, 1879). Reichert and Weir Mitchell found that sodium and potassium nitrites had physiological actions almost identical with that of amyl nitrite (*Am. J. Sc.*, 1880). Gamgee pointed out that their action on the blood—rendering it brown—resembled that of nitrite of amyl (*Proc. Roy. Soc. Ed.*, 1867), and various authors, as Drs. Hay (*Pract.* 1882) and Leech (*B. M. J.*, ii., 1885 ; i., ii., 1893, etc.), have found clinically that it closely resembles other nitrites in action, but being less volatile it is much more slowly excreted and maintains its action longer. Its action is, moreover, purely that of nitrous acid, which is not

the case with ethyl or amyl nitrite: it is less likely than nitroglycerin to cause headache. Dr. G. A. Atkinson gives a very complete description of its action on man and animals (*J. Anat. and Physiol.*, 1888). In frogs it causes progressive enfeeblement of the muscular and nervous systems, with depression of the heart and respiration. It is a very powerful muscle poison, the gastrocnemius muscle of the frog losing its contractility in thirty to forty minutes in a 1 per cent. solution, and in three or four hours in a 1 per 1,000 solution. It has in the frog a more powerful action on muscle than the amyl nitrite; the muscles are paralysed before the cord with the sodium salt, the reverse is the case with the amyl nitrite.

Circulatory System.—It is upon the circulation and especially on the tension of the arteries that the main action of these medicines is exerted. Within three minutes of taking a 2 gr. dose of sodium nitrite the tension falls, and the pulse quickens more or less, becoming softer and fuller.

Flushing of the face does not occur so constantly as when a vaporous nitrite is inhaled, but some fulness and throbbing of the head may be felt, and some perspiration, which symptoms may continue from one to three hours.

With double the dose and up to 10 gr. the same effects become much more marked, and faintness, nausea, cyanosis and semi-unconsciousness may follow (Atkinson). On the other hand, much smaller doses, $\frac{1}{16}$ gr., have been known to affect slightly very susceptible subjects with naturally low tension. The lowering of tension is due to relaxation of the vessel walls, chiefly caused by a paralysis of their muscular fibres or contained ganglia—partly by depression of the vaso-motor centre (Brunton, Leech and others). In the blood, nitrites convert the hæmoglobin into a mixture of methæmoglobin and nitric-oxide hæmoglobin, in which the oxygen is more firmly combined than normal, and is not so available for nutritional changes, although if the dose is not excessive, the compound and the resulting cyanosis may be got rid of by the vital processes (Haldane and others, *Journal Physiol.*, 1897; see also Amyl Nitrite in next volume of this work). Whilst small doses increase the working power of the heart, large ones have an opposite effect (*Winkler. Ztsch. f. klin. Med.*, Bd. 35).

After death in mammals from toxic doses the venous system

has been found greatly engorged, the blood chocolate-brown, the right ventricle dilated, the left contracted. Of the other systems it may be stated that medicinal doses have no special influence on respiration in healthy men, though they may dilate the lung vessels, and toxic doses cause congestion. On the cerebrum they have not much influence except through the circulatory changes, but they diminish reflex excitability of the cord: locally applied they lessen or annul the functions of all tissues. On the digestive system they sometimes act as irritants, causing eructations, sickness or diarrhœa, but not usually. They can dilate the renal vessels and thus cause more or less diuresis. The observation that they increase the excretion of uric acid has not been verified (Leech in Hale White's Text-book, 1901).

THERAPEUTICAL ACTION.—*Internal.*—**Epilepsy.**—Dr. W. T. Law treated a case of epilepsy with the salt, giving doses of 20 gr., and the result was favourable (Pract., i., 1882). Dr. C. H. Ralfe also found the drug sometimes useful in epilepsy, where potassium bromide produced no improvement (Lancet, ii., 1882).

The papers of Drs. Ringer and Murrell brought the drug prominently before the notice of the profession, whilst it showed the danger of giving the pure drug in such large doses as Dr. Law had previously used. The latter obtained no ill effects from 20 gr. doses because the salt he used was largely adulterated with the nitrate, but the above observers found that doses of 10 gr. may produce dangerous symptoms, of which the most prominent are giddiness and sickness (Lancet, i., 1883). This paper caused many practitioners to abandon the use of the drug altogether as dangerous, but there can be no doubt that in doses of 2 to 3 gr., gradually increased if necessary; it is worthy of trial in cases where bromides are of no avail, especially when attacks are frequent, and in the *petit-mal* of children.

Asthma.—**Bronchitis.**—In these conditions where there is spasm of the bronchial muscle, as Sir Thomas Fraser has shown, great relief is given to the dyspnœa by the action of nitrites: this can be recognised on auscultation by disappearance of the sibilant and rhonchial sounds. Dr. Pearse has recorded cases of asthma relieved by 3 to 4 gr. doses of nitrite of sodium (Pract., 1891). In nine cases of bronchitic asthma, in neurotic subjects,

I tried it, but in none was definite relief experienced. Nitrites are developed in the burning of most "asthma powders".

Angina pectoris.—As Dr. Hay has pointed out the similarity between nitro-glycerin and the nitrites of amyl and of sodium in physiological action, so also he has demonstrated that the last may be employed in angina pectoris like the other two drugs mentioned; the effects are less quickly produced, but continue for several hours longer. It is also of use in pseudo-angina and in irregular cardiac action and dyspnœa, not, however, if the lung is œdematous. Dr. Hay has proved that the nitrous acid is the main element that affords relief, and independently of the base with which it is conjoined, though amyl has also some influence. Sir Lauder Brunton's observations tend in the same direction (*Pract.*, i., 1883).

In chronic Bright's disease the sodium and other nitrites have been used as diuretics, and in dysmenorrhœa as antispasmodics.

STANNUM—TIN, Sn = 118. (118.20.)

This metal is known to occur only in the mineral kingdom, and in minute quantity in the water of Saldschütz.

CHARACTERS AND TESTS.—Silver-white in colour, with a tinge of yellow and high metallic lustre, unaffected by moisture or exposure, inelastic, but flexible: when rubbed it imparts to the fingers a peculiar odour. It is a good conductor of heat and electricity, has a specific gravity of 7.292, melts at 442° F., and at a higher temperature burns with a brilliant white light: at ordinary temperatures it is not brittle, but when heated to near the fusing point may be easily powdered. Nitric acid does not act upon it, except in presence of water; hydrochloric acid dissolves it with evolution of hydrogen. *Granulated tin* (B.P.) is the metal reduced to small fragments by pouring it when fused into cold water.

Solution of *stannous chloride*, SnCl_2 (Appendix, B.P.), absorbs oxygen readily and hence is a powerful deoxidising agent. It reduces to the metallic state the salts of mercury, silver, gold, etc., and is made use of for this purpose; also as a test for ammoniated mercury.

PHYSIOLOGICAL ACTION.—*Internal.*—The metal itself is inert, but if taken into the stomach may be so far acted on by acids or saline substances as to be rendered soluble in the form of

chloride, and may then produce some irritant effects. The fact of such a change sometimes occurring and sometimes not may explain the disagreement between the results of Orfila, who considered oxide of tin to be a poison, and Schubarth, who considered it inert. Patenho, of St. Petersburg, gave to dogs 3 gr. of finely powdered tin daily for six weeks without any effect; he could detect none in the urine—it seemed all to pass by the fæces. Dr. T. P. White attributes to tin a direct irritant action on the intestine, as well as tremor and weakening of functions such as the respiratory, which depend on the cord and the medulla (Phar. J., 1887). Tin causes spasm of the muscular wall of the intestine like lead, and Brunton and Cash have shown that salts of tin cause powerful contractions of the blood-vessels. It is said to act on the spinal cord so as to produce paralysis of the limbs and later of the heart.

It has been said that fatty, or acid, or simply albuminous articles of food, after having been kept in tinned vessels (free from lead), have sometimes occasioned colic and vomiting, but this must be exceptional; the metal has, however, been recovered from the urine in these cases. We may note that arsenic is a usual constituent of tin-ores, and in small quantity it is generally present in all tin that has not been carefully purified, and irritant effects may have occurred from it.

The *chloride* or "*butter of tin*" is stated to exert a tonic, anti-spasmodic effect when given in small quantities, but in large doses it causes muscular twitching, convulsion, and paralysis; also some gastro-intestinal irritation, with dryness of the mouth and throat. Patenho found the bichloride given subcutaneously cause local anæsthesia, and if in strong solution, gangrene; in the veins less than $\frac{3}{4}$ gr. proved fatal—by the stomach it only caused some indigestion.

THERAPEUTICAL ACTION.—Intestinal Worms.—As a matter of historical interest, it may be recorded that the powder of tin (tin filings) has been used as a vermifuge in cases of lumbricus and tænia.

As Trousseau remarked, of all metals after mercury tin has been in the highest repute as an anthelmintic, and many secret vermifuges contain either the finely powdered metal or its sulphide: from 30 gr. to $\frac{1}{2}$ oz. have been given in electuary. Alston gave 1 oz. at a time, but found that severely irritant effects sometimes

followed. Professor Stillé quotes several authorities in favour of the remedy, and Dr. Graves speaks well of it (Lectures), but it is not now used, because more trustworthy medicines have been found. It is supposed to act either mechanically or by chemical effects, but in Patenho's experiments worms were not expelled under its use, as they were found in the intestines on section (Lancet, i., 1886). Salts of di-stann-ethyl have a strong purgative action (Jolyet and Cahours).

In **Epilepsy, Chorea**, and allied forms of nervous disorder, the chloride of tin was formerly given, and with benefit, according to the observations of Dr. Schlessinger (Med. Chir. Rev., Oct., 1838, and April, 1846), probably in the same way that the salts of zinc are still used in the treatment of nervous diseases.

In **Chronic Skin Diseases**, such as eczema and torpid ulcers, the same physician has recommended it both internally and in lotion, but its real value is not ascertained.

PREPARATIONS AND DOSE.—*Pulvis stanni* (not off.): dose, 20 to 40 gr. as a vermifuge—it may be given in honey or treacle three or four times daily for several days, and should then be followed by a cathartic. *Stanni chloridum*: dose, $\frac{1}{6}$ to $\frac{1}{2}$ gr. two or three times daily in pill or in chloric ether—a *lotion* may be made with 1 gr. to the ounce.

URANIUM (U = 240). (*Not official.*)

This metal was discovered in 1789 by Klaproth, who named it after the planet Uranus (identified a few years before), and obtained it from pechblende or pitchblende, an ore which contains about 80 per cent. of the black oxide, from which ore also radium and other rare metals have been separated. M. Péligot obtained it like aluminium and magnesium by decomposing its chloride by means of potassium and sodium. Thus separated, the metal appears partly in the form of a black powder, and partly in masses or plates, which may show a metallic lustre like silver.

Uranium is very combustible, and burns at a moderate degree of heat with a white shining light—indeed, at so low a temperature that it may burn on paper without setting this alight: after combustion it becomes converted into a green oxide.

It does not alter on exposure to air, or decompose water, but it dissolves in dilute acids with evolution of hydrogen. In chemical character it somewhat resembles iron and manganese, and it is remarkable in having the highest atomic weight yet recognised (except radium).

COMPOUNDS OF URANIUM. (*Not official.*)

There are several oxides of uranium, of which the best known is the peroxide (U_2O_3). This is used in colouring glass, to which it gives a fine lemon yellow. The nitrate of this peroxide ($\text{U}_2\text{O}_3\text{NO}_5 + 6\text{HO}$) is the one most used in medicine, and occurs in large yellow regular prismatic crystals, which effloresce in vacuo, losing half their water of crystallisation, and are very soluble in water. They generally contain some free nitric acid, and have an astringent styptic taste.

The double chloride of uranium and quinine occurs in small yellow granular crystals, which are less soluble in water—1 in 100.

ABSORPTION AND ELIMINATION.—Mr. Symonds having failed to find uranium in the urine of one of Dr. West's patients taking it, the latter suggested that it does not enter the general circulation, but when absorbed from the digestive tract passes only between that and the liver (B. M. J., ii., 1895). Dr. Bond had a similar experience, for in one patient who had been taking 90 gr. of the nitrate daily for twelve months several analyses of the urine were made without finding any of the salt or the metal, although so little as 1 in 2000 may be detected when present in solution (Pract., 2, 1898).

PHYSIOLOGICAL ACTION.—Digestive System.—The earliest observations are those of Gmelin (1824), who reported vomiting in dogs to whom he gave uranium. Chittenden found that small doses of the nitrate lessened the action of ptyalin, pepsin and trypsin, and formed an indigestible compound with albumin; moreover, $\frac{1}{8}$ gr. acted very much as 1 gr. did. Full doses acted like an irritant poison to the gastro-intestinal tract (Therap. Gaz., 1888; Zeit. f. Biol., 1889). Mr. E. Blake reported ulceration of the stomach and duodenum resembling that produced by bichromates and by arsenic.

Urinary System.—Lecomte in 1851 was the first to state

that continued small doses caused glycosuria in dogs (Brit. For. Med.-Ch. Rev., 1857). Chittenden obtained a similar result from full doses, and the appearance of sugar was preceded by nephritis; he considered that there was a destructive action on the renal epithelium of the same nature as that caused by the toxic action of mercury and phosphorus (*v. p.* 685), under the administration of which also sugar has been found. He met with evidence of tolerance, *e.g.*, the dose that at first soon caused albuminuria and was then omitted did not when resumed cause the same symptoms till after a much longer time and till a larger quantity was taken. Blake denied the production of glycosuria by any dose.

Circulatory System.—Rabbits in the experiments of Gmelin died of cardiac paralysis after doses of 34 gr. by the mouth and 3 gr. by intravenous injection. Chittenden reported similar results, together with emaciation and failure of locomotor power: under small doses the temperature was raised and the excretion of carbonic acid increased.

SYNERGISTS are as indicated in the preceding remarks.

ANTAGONISTS would be demulcents and remedies for gastric irritation and for collapse.

THERAPEUTICAL ACTION.—*External.*—**Pharyngitis.**—Sir G. D. Gibb many years ago recommended uranium nitrate solution as a local application to the fauces in sore throat, especially in glycosuric subjects, and it is still occasionally used as an astringent like silver nitrate; a spray—10 gr. to the ounce—is the best form.

THERAPEUTICAL ACTION.—*Internal.*—**Diabetes.**—Attention was especially directed to this subject by the favourable results reported by Dr. S. West (B. M. J., ii., 1895), although Dr. R. Hughes and others had previously referred to it in a less precise manner. Of Dr. West's eight cases, all but one are said to have improved more or less markedly, and the one exception was unable to take full doses because of dyspepsia; the remedy was found to lessen thirst and the general symptoms of the illness, as well as the sugar and the diuresis, and possibly acted by checking the rapid digestion of starch, and of some forms of albumin, thus controlling excessive pancreatic digestion. In a later paper (*ibid.*, September, 1896) he somewhat qualified his favourable opinion. Support was given to it, however, by Dr. Bond's asylum cases, nine in number,

published in the Jour. Ment. Sci., 1896-7. He began with 3 gr. doses thrice daily, and these caused no dyspepsia or albuminuria, but lessened the sugar, benefited most of the cases, and apparently cured one case of "true diabetes," without change of diet and after failure of codeine; after increasing to 6 gr. doses there remained in three weeks only a trace of sugar in the urine, and this quite disappeared under 10 gr. doses. In three cases of obese diabetes it was partially successful; one took 30 gr. thrice daily for nearly twelve months without other than good results. Dr. Bradbury reported the case of a boy in whom the sugar and the amount of urine were lessened, though the doses of 12 gr. caused diarrhœa—there was no change as to albumin or acetone; the action seemed "slow to begin and slow to end" (West).

Dr. E. Duncan (Glasgow) brought forward four cases (B. M. J., ii., 1897) also showing improvement, and concluded that the drug had "a stimulating effect on the sugar-consuming cells," and was more suitable for "neurogenous than for pancreatic cases"; he gave 5 to 20 gr. doses thrice daily, without drawback.

In the discussion on this paper Dr. Tyson (Philadelphia) stated that his trials of the drug had given him no good result, and that he could not give more than 5 gr. doses without bringing on diarrhœa.

Dr. Saundby had given as much as 30 gr. doses, but could get no specific effects.

Since that time but little has been heard of this medication, though it is still occasionally employed, and perhaps deserves further investigation. Dr. Mackey's experience, mostly in hospital practice, has not been favourable, but in the few cases in which he prescribed it its steady continuance was interfered with by the occurrence of diarrhœa.

Uranium nitrate has never, in my experience, justified the praise it has sometimes received. I gave it a fair trial in twenty-six cases of diabetes mellitus, keeping the patients steadily under its influence for more than two months, and during that time never observed any decided good effect which could be attributed to the action of the drug; the doses used were from $\frac{1}{2}$ to 5 gr. three times daily. The first week each patient took $\frac{1}{2}$ gr. doses, the second week 3 gr., and afterwards 5 gr. In none of these cases was the sugar lessened, or the thirst or dry skin relieved,

and in none of them was dyspepsia or albuminuria produced. In seven cases there was slight looseness of the bowels, but no diarrhoea.

PREPARATIONS AND DOSE.—*Uranii nitras* (not off.): $\frac{1}{2}$ to 5 gr. and upwards. *Uranii et quininae chloridum* (not off.): 3 to 6 gr. *Vin urané* (Pesqui) is a palatable French form (Bordeaux).

ZINCUM—ZINC, $\text{Zn} = 65$ (64·91).

This mineral is obtained for commercial purposes, mainly from two ores—the carbonate (calamine) and the sulphide (blende)—by distillation with carbon. It has been found also in plants which grow on the calamine hills of Rhenish Prussia. It is liable to contain admixtures of arsenic, iron, copper, and sulphur. Alloyed with copper, zinc forms brass, with nickel, “German silver”. It is extensively used in galvanic combinations, and forms the positive plate of many voltaic batteries; as a coating on iron (galvanised iron) it protects that metal from oxidation. *Granulated zinc* is prepared by pouring the molten metal into cold water.

CHARACTERS AND TESTS.—Zinc is a brittle bluish-white metal, which at a red heat burns with a brilliant flame and emits white fumes of oxide; its specific gravity varies from 6·8 to 7·2. It is the only metal which yields a white sulphide with sulphide of ammonium, and hence this reaction is the characteristic test for it. Fixed and volatile alkalies also give with zinc white precipitates, soluble in excess of the reagents.

COMPOUNDS OF ZINC.

ZINCI OXIDUM—ZINC OXIDE ($\text{ZnO} = 81$).

CHARACTERS AND TESTS.—A white heavy powder, without taste or odour, insoluble in water, soluble in acids; moderate heat renders it yellow. Commercial specimens are often impure from the presence of carbonates, sulphates, chlorides, iron, etc.

ZINCI CHLORIDUM—ZINC CHLORIDE ($\text{Zn Cl}_2 = 136$).

CHARACTERS.—Chloride of zinc is soft, white or semi-transparent, crystalline or waxy, and is met with either in opaque tablets, or in pencils like

nitrate of silver. It is very soluble and deliquescent, but if mixed with an equal part of oxide (oxychloride) may be kept dry for a long time.

ZINCI SULPHAS—ZINC SULPHATE—WHITE VITRIOL
($\text{ZnSO}_4 \cdot \text{H}_2\text{O} = 287$).

CHARACTERS.—It occurs in prismatic crystals, which may be large or small. The latter much resemble in appearance those of sulphate of magnesium, but their strong styptic taste will distinguish them from the bitter magnesium salt; they redden litmus and effloresce in air.

*ZINCI CARBONAS—ZINC CARBONATE OR HYDRO-
OXYCARBONATE* ($\text{ZnCO}_3(\text{ZnH}_2\text{O}_2)_2 \cdot \text{H}_2\text{O} = 341$).

CHARACTERS.—A soft, white powder, resembling magnesia, insoluble in water, tasteless and inodorous.

ZINCI ACETAS—ZINC ACETATE ($\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 3\text{H}_2\text{O} = 236$).

It occurs in thin, lustrous, micaceous plates, having a sharp astringent taste.

*ZINCI VALERIANAS—ZINC VALERIANATE OR
ISOVALERIANATE* ($\text{Zn}(\text{C}_5\text{H}_9\text{O}_2)_2 = 267$).

CHARACTERS.—It occurs in brilliant scaly crystals which have an odour of valerian and a metallic taste; they are soluble slightly in cold water or ether, freely in hot water and in alcohol. It is liable to be contaminated with butyrate of zinc.

*ZINCI SULPHOCARBOLAS—ZINC SULPHOCARBOLATE OR
PHENOL-PARA-SULPHONATE*
($\text{Zn}(\text{OH} \cdot \text{C}_6\text{H}_4 \cdot \text{SO}_3)_2 \cdot \text{H}_2\text{O} = 429$).

CHARACTERS.—It occurs in colourless, transparent, tabular efflorescent crystals, which are soluble in about twice their weight of rectified spirit or of water.

OLEATUM ZINCI—ZINC OLEATE.

A fine pearl-coloured powder, smooth to the feel like "French Chalk."

Other compounds of zinc which are used medicinally, but which are not official, are the *bromide*, the *iodide*, and the *phosphide*.

ABSORPTION AND ELIMINATION.—Soluble salts of zinc, such as the *chloride*, *sulphate*, and *acetate*, are readily absorbed, and pass into the blood probably as albuminates. The *oxide* and the *carbonate* are also dissolved to some extent by the acids of

the gastric juice, and then slowly absorbed; independently of clinical evidence of this, the oxide has been detected by Schlossberger in the urine, and by Michaelis in venous blood.

Zinc does not seem to be deposited in the tissues in the same manner, or for so long a period, as mercury, lead, or copper, although Lechartier and Bellamy have detected it in the bodies of animals to whom the metal had been previously administered (Med. Record, i., 1877). The soluble salts are eliminated soon after being taken, but the insoluble ones are not found in the excretions until four or five days afterwards (Michaelis). The metal passes out mainly by the bile and the intestinal secretions; in smaller amount by the urine.

PHYSIOLOGICAL ACTION.—*External.*—The oxide and the carbonate of zinc in powder act mechanically as absorbents and sedatives. The sulphate and the acetate in the solid state act as efficient but not very severe caustics if the epidermis be removed; in dilute solution they act as astringents. The chloride and nitrate exert a strongly caustic effect by virtue of their affinity for water, and their power of coagulating albuminous material; the former especially, being deliquescent, penetrates deeply into the tissues, and causes severe burning pain; the eschar produced is white and hard, and separates in five or six days; when formed from deep tissues it is of a spongy character, but dry on exposed surfaces. Zinc chloride is a powerful disinfectant, and even in dilute solution proves fatal to bacteria, etc.; according to Calvert's experiments, it is only equalled in efficacy by mercurial chlorides and the tar acids (Lancet, ii., 1873; Med. Times, ii., 1852).

PHYSIOLOGICAL ACTION.—*Internal.*—**Digestive System.**—The oxide and carbonate, in doses of a grain and less, exert an astringent and somewhat sedative action on the gastro-intestinal tract, markedly lessening its secretions. The sulphate in small non-irritant doses is still more astringent. All zinc compounds have a tendency to excite nausea and irritation of the stomach; the oxide and the carbonate, though tasteless, show this effect when given in doses of from 1 to 5 gr. and upwards. The soluble salts have a styptic metallic taste, and the sulphate, in doses of 10 gr. and upwards, acts as a prompt and thorough emetic without much nausea or prostration, though often with

diarrhœa; this action is not purely a local one, because it is equally produced by intravenous injection of the salt. Emesis, however, is not a constant effect, for if the drug be taken at first in small doses and continued regularly, a certain tolerance is established, and then 10 to 20 gr. doses may be taken without disorder of the stomach. Caution is required in the continuance even of small doses, since they have been said to cause ulceration of the mucous membrane, and ultimately symptoms like those of lead poisoning, such as emaciation, anæmia, debility, fœtor of breath, constipation and colic, also tremor and paralysis. Symptoms of acute irritant poisoning, such as pain, vomiting, convulsions and collapse, have followed doses of 30 to 60 gr. and sometimes concentrated solutions have caused death (Med. Times, ii., 1862), but the salt has rarely proved fatal, because of its being so soon rejected; persons have recovered after taking an ounce or more.

The chloride is much more corrosive in character, and is unsuited for internal use—5 to 10 gr. have produced severe irritant symptoms. It has been a not infrequent source of fatal poisoning in the form of Sir W. Burnett's disinfecting fluid, which is an impure solution of it, somewhat oily in character, and either colourless or of yellowish tinge, from the presence of some ferric oxide; it has been mistaken for fluid magnesia, for mineral waters, and for pale ale, the fact of its frothing up when shaken contributing to its resemblance to the last mentioned; 1 fl. oz. has been found to contain from 100 to 372 gr. of solid chloride, and less than that quantity has proved fatal, though not invariably.

Circulatory System.—The heart in frogs is rendered weak by the administration of zinc salts. Its action becomes slow and irregular and it stops in diastole. In mammals also the pulse is slowed, but small doses in them are said to strengthen the heart's action. According to Grohe and Kobert the drug forms a compound with the hæmoglobin of the blood (Kobert's *Pharmak. Arbeiten*, ix.).

Nervous System.—The oxide of zinc has been credited with a special action on the nervous system, of tonic character in small, but depressant in large doses. Dr. Marcet traced drowsiness to its use, and others have recorded giddiness after taking it, and

generally depressed nervous and mental conditions from the prolonged continuance of large doses (Med. Times, 1858; Med.-Chir. Rev., ii., 1861). In cases of ultimate recovery from the effects of large doses of zinc salts there have been, besides the gastric symptoms, signs of impaired nervous power, with perversion of taste and smell, tremor or partial paralysis. Exposure to fumes of the molten metal, as in the course of certain metallic castings, gives rise to a curious train of symptoms, mainly nervous, and commonly known as "brassfounders' ague," including general malaise, "tightness of the chest," a cold stage with rigors, followed by a hot stage with profuse sweating. These symptoms may occur periodically for several days. Schlockow states that zinc smelters die early with pulmonary catarrh or myelitis (Deut. med. Woch., 1879); but Oliver remarks that the ore often contains arsenic and lead. Workmen who use the oxide in painting, calico-printing, etc., do not suffer. In the frog, zinc lowers reflex excitability when injected into the veins; it is said too that the muscles respond less readily to electricity.

Cutaneous and Renal Systems.—The internal administration of the oxide or other astringent zinc salts checks the secretions of the skin.

Helpup made a large number of experiments on rabbits and cats with zinc salts, given subcutaneously and by the mouth, for several days or weeks. In 79 per cent. of these, parenchymatous nephritis was induced (Deuts. med. Woch., 1889).

SYNERGISTS.—The oxides of silver and of bismuth are much allied in action with oxide of zinc: henbane and belladonna assist its power of controlling perspiration. The chloride of zinc resembles in corrosive and disinfectant properties the chloride of mercury, and both the chloride and nitrate are allied in action with other mineral caustics.

ANTAGONISTS.—The chemical antidotes in cases of poisoning by the corrosive compounds of zinc are lime-water, alkaline carbonates and tannic acid; these should be given in mucilage or milk. Valerianate of zinc is decomposed by acids and by most metallic salts. Purgatives and diaphoretics interfere with the action of zinc salts.

THERAPEUTICAL ACTION.—*External.*—**Lupus, Cancer, etc.**—The chloride of zinc was first introduced as a secret remedy

for cancer by Canquoin in Paris in 1837, and was combined with sanguinaria in the paste of Dr. Fell, which had a temporary popularity (Med. Times, i., 1858). Veiel recorded excellent results from its use in lupus (Med.-Chir. Rev., ii., 1860), and it is certainly a trustworthy escharotic. I have seen immediate improvement from it in some very severe cases, especially of facial lupus and rodent ulcer. It has disadvantages in being deliquescent, and hence readily penetrating adjacent healthy tissues and disposing to hæmorrhage, but when mixed with flour, zinc oxide, or better still with calcium sulphate or gutta-percha, it becomes quite manageable. The nitrate of zinc, though not in such frequent use, has, perhaps, advantages over the chloride; according to Mr. Marshall it penetrates deeper and causes less pain: in lupus it was commended by the late Dr. Tilbury Fox, and I have had successful results with it, generally using a paste made with equal parts of nitrate, flour and mucilage spread on lint.

In *lupus erythematosus* a lotion of zinc sulphide is sometimes useful, but may irritate.

Both the nitrate and chloride are equally applicable to all forms of strumous and syphilitic ulceration. Franchi reports arrest in some very severe cases of this kind, when acid nitrate of mercury and iodine had been tried without success (Gaz. Méd. de Paris, Feb., 1876). Maisonneuve used the chloride made into a firm paste with flour in the form of flèches ("arrowheads") which he thrust into incisions all round a morbid growth, thus destroying a zone of tissue and separating the tumour; but this process is more painful and prolonged than the use of the knife, and does not prevent recurrence better than an equally extensive incision. A similar application in the form of crayon has been applied by Condamin to the destruction of uterine fibroids in place of hysterotomy (Lyon Méd. Mai, 1893).

Sir J. Y. Simpson advocated sulphate of zinc in powder as the best caustic for these maladies, whether affecting the uterus or other parts: it is simple, easily applied and managed, safe, efficient, fairly rapid in action (five or six days), and does not deliquesce. In cases where the epithelium was destroyed, he applied the anhydrous salt in fine powder or mixed with glycerin into a paste (1 oz. of sulphate to 1 dr. of glycerin). In other cases, *e.g.*, of cancer of the breast, he mixed the salt with

sulphuric acid and scored the part with a quill at successive applications (Med. Times, i., 1857 and 1859); he records many good results, which were to some extent corroborated, but his practice has not been largely followed. Sir John Erichsen found that it gave great pain to patients (*ib.*).

Surgical Tuberculosis.—Lannelongue, Semalзки and others have treated surgical tuberculosis by injecting solutions of chloride of zinc around the diseased part. A solution of 1 in 10 may be used and from 7 to 10 drops be injected at one time in from twelve to twenty places. The injection may be repeated at intervals of one, two, or three weeks.

Adenitis.—In cervical adenitis which will not subside under general treatment—neither softening nor disappearing—Calot recommends that 30 to 40 drops of a 2 per cent. solution of chloride of zinc should be injected into the glands. He repeats this process three or four times every second day and the glands almost certainly soften (Presse Méd., October, 1898).

Warts.—**Nævi.**—The strong chloride is useful for destroying warts and superficial nævi. Mr. Weeden Cooke has suggested a convenient mode of applying it, *viz.*, by soaking lint in the deliquescent salt, drying it, and cutting off suitable pieces when required: if covered it will preserve its power for many weeks (Med.-Chir. Rev., Jan., 1866).

Wounds.—C. de Morgan and others recommended the sponging of recent wounds, whether from accident or operation, with strong solutions of zinc chloride (20 to 40 gr. in the ounce) as a powerful antiseptic. This had a good effect in lessening risk of septicæmia, etc., but was in a measure superseded by the more detailed and exact method of Lord Lister. It is, however, still largely used, and is valuable in many cases: it cleanses the wound and any old sinuses, and lessens and prevents suppuration. Some surgeons employ it specially after the excision of malignant tumours.

Eczema.—**Erythema.**—The oxide and the carbonate of zinc and calamine form useful sedative, absorbent, and protective powders for inflamed surfaces, and sometimes are indicated when serous discharge is present: they are generally mixed with $\frac{1}{4}$ to $\frac{1}{2}$ part of a neutral powder, such as that of orris-root, starch, or magnesia. They may be used also suspended in mucilaginous liquids as a good lotion, *e.g.*, for erythematous acne of the face

or in the form of ointment of oleate of zinc (Crocker, B. M. J., i., 1879), or with vaseline or benzoated lard: benzoated zinc ointment, when properly made, is an excellent application for irritative and eczematous conditions. The "paste" of Lassar is made with zinc oxide and finely powdered starch of each 25 parts, vaseline, 50 parts, and salicylic acid, 2 parts. A lotion containing 5 gr. of sulphate in the ounce relieves the itching of eczema and other skin diseases, but is liable at first to cause some smarting: a strength of 15 gr. to the ounce with the same of sulphuret of potassium mixed with glycerin and rose-water may be useful in acne vulgaris (W. A. Jamieson), but I have found it too irritant.

Relaxed or Discharging Mucous Surfaces.—For ordinary relaxed or discharging surfaces, when astringents are indicated, the sulphate of zinc is one of the best: from 1 to 2 gr. in the ounce of distilled water is a usual strength, and combined with a stimulant such as spirit of rosemary or lavender this forms the ordinary "red lotion" of many hospitals, and is suitable for any indolent atonic ulcerations; sulphocarbolate of zinc also makes a good detergent lotion.

For catarrhal *throat affections* accompanied with deafness Dr. Druitt finds zinc sulphate in solution act better than ordinary acid gargles, and Mr. Nunn reports similarly as to the chloride (Med. Times, i., 1857); a spray containing this is excellent for relaxed pharynx and congested vocal chords.

In catarrhal *conjunctivitis* and *otorrhœa*, collyria and weak warm injections of the same salts (2 gr. to the ounce of water) are useful, and 4 gr. to the ounce is a good strength for injection in *ozæna*; morphine, atropine or carbolic acid may be combined with the astringent.

The chloride lotion is also valuable in *gonorrhœal* and *purulent ophthalmia*, and Mr. Hutchinson reports it as less painful than silver nitrate, and sometimes completing the cure when that remedy failed (Lond. Hosp. Rep., 1867-68).

In *leucorrhœa* and *gonorrhœa*, injections containing 1 to 2 gr. (or more) of zinc sulphate or sulphocarbolate to the ounce, or $\frac{1}{8}$ gr. of zinc permanganate, are very suitable after the early acute stage has subsided (Med. Times, ii., 1870); they are sometimes better combined with an equal quantity of lead acetate. As a general rule, the more acute the condition the more frequently should a

weak solution ($\frac{1}{2}$ gr. or less in the ounce) be applied, and as the inflammation becomes less or passes into a chronic stage, one or two applications daily of a double or treble strength are best. A stronger solution (1 to 10 gr. in the ounce) is advisable, but used less frequently, in more chronic cases. The chloride, and indeed many other astringent salts, may be used in a similar manner with advantage.

THERAPEUTICAL ACTION.—*Internal.*—**Narcotic and other Poisoning.**—Zinc sulphate is a good emetic for cases of this kind : 10 gr. in warm water is an average dose, but 20 gr. is the amount preferred by many practitioners ; if the mouth be firmly closed it may be administered by a tube passed through the nose into the gullet, or by the stomach pump through a gag, and if the larger dose be used, its after-rejection must be secured. When an emetic is given by the stomach, its bulk has an effect in securing the result : thus the greater quantity of warm water that can be given with the zinc sulphate, the better it will act : time also makes a difference, for smaller doses given slowly have acted better than large ones quickly swallowed. In some cases a few grains have been given by intravenous injection, and have produced emesis.

Gastralgia.—Diarrhœa.—Professor Gubler, having remarked the analogous effects of the oxides of zinc and of bismuth, suggested the substitution of the former when expense was an object, and experience has proved that the zinc compound will often act in an extremely satisfactory manner in relieving gastric pain, especially when this is followed by diarrhœa from undigested food ; it has, however, more tendency to nauseate than the bismuth salt. The dose should commence at 1 gr. and not exceed 3 gr., and should not, as a rule, be given on an empty stomach. Its main effect is probably mechanical.

In *dyspepsia* connected with oxaluria Bartholow has found the sulphate useful, and Gillespie also recommends it (Boston Journ., May, 1868).

Dr. Brakenbridge, of Edinburgh, was one of the first to draw attention to the value of zinc oxide in *infantile diarrhœa* (Med. Times, i., 1873), and I have, in common with many others, found it an efficient and non-irritant astringent, especially so in unstable nerve-conditions as during dentition or pertussis.

In *chronic* diarrhœa, and even in *dysentery*, the oxide has acted very favourably, but the sulphate has more decided powers.

Bronchorrhœa.—Excessive secretion from the bronchial tubes is controlled by the oxide and by the sulphate of zinc.

Cardiac Disease.—The cyanide of zinc (in doses of $\frac{1}{10}$ to $\frac{1}{8}$ gr.) three times daily has proved of service in disease of the heart. It is said to have a digitalis-like action and to quiet palpitation and remove irregularity (Lancet, ii., 1887).

Hyperidrosis.—I can entertain no doubt of the power of zinc oxide to control excessive sweating in phthisis and other exhausting diseases, although it has been denied by some observers. Dr. T. Thompson, one of the first to record this effect, found it increased, as we should expect, by conjunction of the zinc with henbane extract—he prescribed 4 gr. of each substance (Med. Times, i., 1854); and W. Curran and others have corroborated his observations (Lancet, i., 1854; ii., 1868). I generally order 1 or 2 gr. of the oxide with the same quantity of extract of henbane, to be taken at bed-time, and again in the course of the night if necessary. The local application of the oleate in powder is often good, especially in osmidrosis. Thymol, 1 in 500 parts, may be added.

Epilepsy.—The value of zinc salts in disorders of the nervous system has been much disputed, some physicians, as M. Herpin, recording extraordinary results from them, and others, as M. Gubler, denying to them any power.

There can be little doubt that the high estimate formed by M. Herpin of the efficacy of the oxide, and later of the lactate of zinc, in epilepsy, is unfounded—no other observer has verified his results; at the same time we cannot deny altogether their power in some cases. Dr. Wilks has seen benefit from the oxide (Med. Times, i., 1869), and Sir E. Sieveking records successful results, though he does not value it highly. Others have thought it more applicable when the epilepsy was complicated with gastric disorder, and others again have seen the best results from it when used in conjunction with digitalis (Lancet, ii., 1868; Med. Times, ii., 1874).

Charcot observed benefit from the bromide of zinc (B. M. J., ii., 1877), and others have advised it in hystero-epilepsy, but Sir William Gowers, in his lectures, considers that salt of little value,

and has found it badly borne. The oxide, however, in his experience, proved sometimes useful, relieving three cases out of ten submitted to it (Lancet, i., 1880).

Chorea.—There is much evidence as to the value both of the oxide and sulphate of zinc in this malady, more, perhaps, in favour of the latter; it should be given in gradually increasing doses up to 15 or 20 gr. (Barlow). Tolerance is soon established and even young children are said to take without difficulty 40 gr. three times daily if well diluted and flavoured (with syrup of tolu, Murrell)—but I have never given such doses. In recording many cases, all of which derived some benefit, Mr. Marsh found that no definite indication for the sulphate could be verified, but that a harsh, dry skin became soft during its administration (Lancet, ii., 1871); it was well borne. In chorea affecting *strumous* children, I can speak well of the iodide of zinc.

Chronic Alcoholism.—Dr. Marcet made many observations on the treatment of this condition, and published a special essay to illustrate the value of zinc oxide in controlling the unsteadiness and the tremor which are its usual accompaniments (Chronic Alcoholic Intoxication, London, 1860; Lancet, i., 1859). Dr. Anstie accorded some, but not so much, value to the drug in the same conditions.

In **Hysteria and Debility**, if anæmia be not extreme, zinc salts often prove useful, but more especially when combined with other nerve tonics; thus, Dr. Barnes speaks very favourably of zinc with phosphoric acid (phosphate of zinc) (Lancet, i., 1858), and has more recently re-stated his opinion as to its value in convulsive diseases of women (Lancet, i., 1873). Vigier finds the phosphide of zinc acts more quickly than phosphorus itself (Bulletin, Jan., 1876), and the valerianate, although decried by many observers, certainly relieves in some cases. Five grain doses thrice daily have apparently relieved *diabetes insipidus* (Lancet, ii., 1883). Zinc oxide may be well combined with such drugs as camphor, galbanum and sumbul.

Spasmodic Cough.—Asthma.—Both the oxide and the sulphate of zinc, especially in conjunction with belladonna, have been found to relieve spasmodic cough, such as whooping cough. In the intervals of spasmodic asthma they are given as prophylactics (Symonds, B. M. J., i., 1868). The valerianate has been

successfully used for obstinate hiccough and for hysterical cough (G. Harley, *Med. Times*, ii., 1863), but, although of some value, is uncertain in its action. In laryngeal spasm 5 to 6 gr. doses will sometimes succeed when smaller ones fail (*Med. Times*, i., 1858). It has also appeared to be useful in hay fever in preventing the recurrence of the attacks.

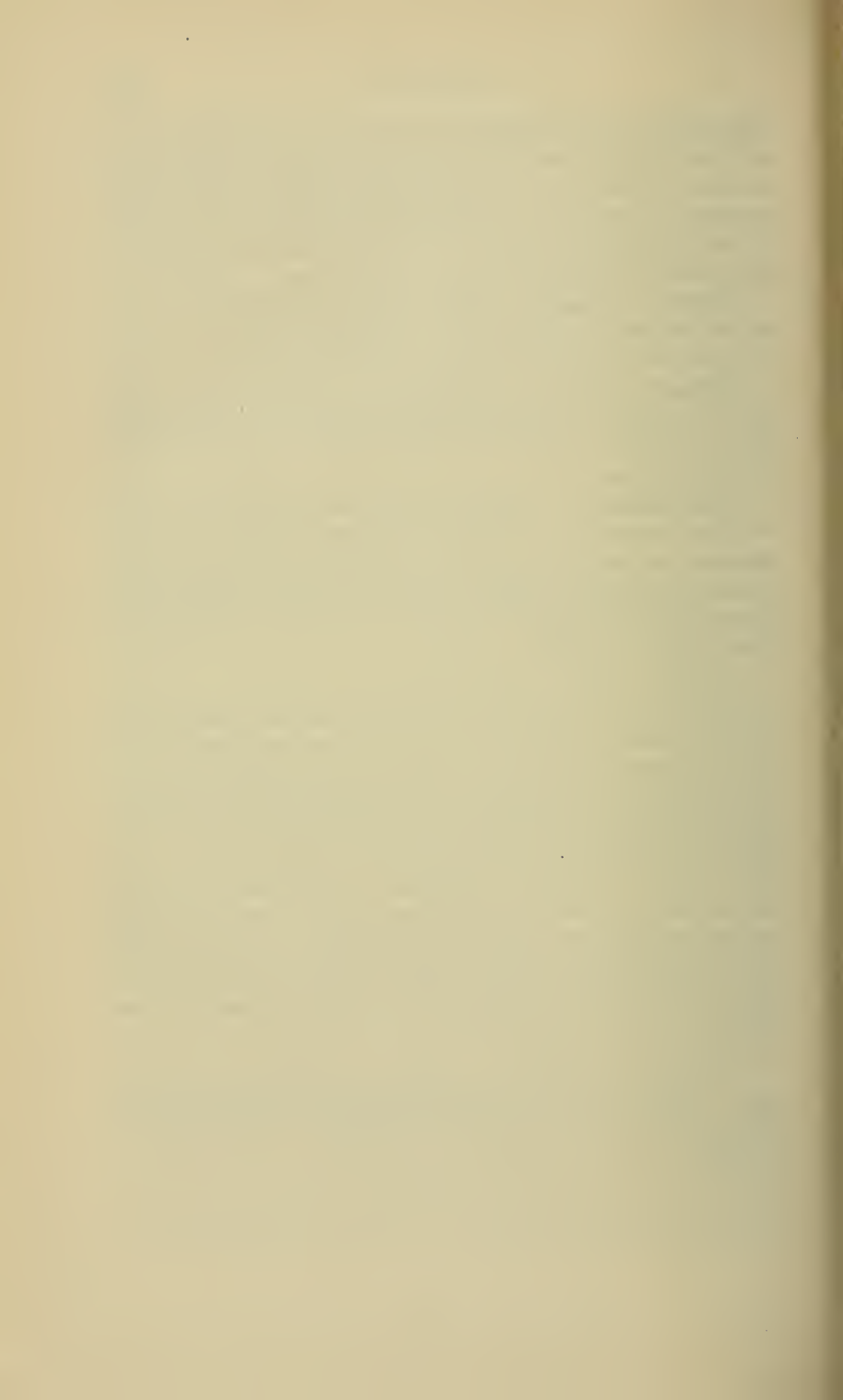
Nervous Headache.—Neuralgia.—The same salt is valuable in nervous headache, and it is specially useful for cases of neuralgia connected with uterine derangement.

Tremor.—In tremor connected with mercurial and arsenical poisoning, Guéneau de Mussy found phosphide of zinc effective (*Lancet*, i., 1876). I have tried it in the tremor of insular sclerosis, but without result.

Rheumatism.—Amongst the rarer uses of zinc salts may be mentioned that of the cyanide in articular rheumatism; it was strongly commended by Luton, as relieving pain and lowering vascular excitement (*Bulletin*, Jan., 1875). Other observers find it also of some, but not marked, value; it is apt to cause headache (*Med. Record*, i., 1877).

PREPARATIONS AND DOSE.—*Zinci oxidum*: dose, 3 to 10 gr. *Unguentum zinci*: made with oxide of zinc and benzoated lard. *Gelatum zinci*: made with gelatine and glycerin (not off.). *Zinci carbonas*: 1 to 3 gr. (tonic), 10 to 30 gr. (emetic). *Zinci sulphas*: dose, as a tonic or astringent, 1 to 3 gr. or upwards; as an emetic, 10 to 30 gr.; for an injection or lotion, from 1 to 10 gr. in the ounce of water. *Zinci acetas*: dose, 1 to 2 gr. as a tonic, 10 to 20 gr. as an emetic; as an injection or lotion, 1 to 10 gr. to the ounce of water. *Zinc valerianas*: dose, 1 to 3 gr. and upwards. *Zinci chloridum*, used in spray or lotion. *Zinci bromidum* (not off.): dose, 1 to 2 gr. *Zinci citras* (not off.) dose, 1 to 2 gr. *Zinci lactas* (not off.): dose, 3 to 10 gr. *Pasta zinci chloridi* (not off.): a caustic made with flour and mucilage. *Liquor zinci chloridi* (B.P.) not used internally. *Zinci nitras* (not off.): used as a caustic in paste. *Zinci permanganas* (lotion $\frac{1}{8}$ gr. to the oz.). *Zinci phosphidum* (not off.): dose, $\frac{1}{16}$ to $\frac{1}{8}$ gr. *Zinci sulphocarbolas*: 1 to 3 gr. to the ounce as lotion. *Unguentum zinci oleatis*, *calamina præparata*, *unguentum calaminæ*, *unguentum zinci borici* (not off.).

Zinci sulphis (zinc sulphite) is used for antiseptic dressings (B. M. J., ii., 1891). A double cyanide of zinc and mercury has proved an efficient antiseptic for external use, and is not so irritant as corrosive sublimate (*Lancet*, i., 1892).



INDEX OF DISEASES AND REMEDIES

(Including remedies treated of in the companion volume.)

ABORTION.

(*Inevitable.*) Gynecological assistance.

(*Recurrent.*) ASAFETIDA. IRON. 653.
IODIDES. POTASH Chlorate, 810.
HYGIENE. HYDRASTIS. VIBURNUM.

(*Threatened.*) Rest. OPIUM. MORPHIA. CODEIA. HYDRASTIS. VIBURNUM.

(May depend on Syphilis, Bright's disease, heart disease, or pelvic disorders, and need special treatment accordingly.)

ABSCESS.

Preventive—

ACONITE in small frequent doses, as in tonsillitis.

AMMONIUM Chloride 1 dr., in Spt. Rosemary 1 pint, as compress, 389.

ANTIMONY, nauseating doses, in tonsillitis or mammary inflammation, 429. Ice.

BELLADONNA with glycerin locally.

IODINE tincture, do., 84. MENTHOL.

PHYTOLACCA Root tinct., 3-5 drop doses: also the powder, 1 dr. to the oz. of Zinc ointment, with 1 dr. Ext. Bellad. and 10 gr. of Camphor—specially for threatened mammary abscess.

QUININE 10 gr. at commencement *e.g.* of tonsillitis.

SALICYLATES. VERATRUM Viride.

Maturing—

BELLADONNA tincture, 5 drops 4 hourly, and ointment, relieve pain and lessen inflammation.

CALCIUM Sulphide in small frequent doses, 39.

Hot fomentations. Poultices.

STRAMONIUM leaves fresh, in hot cataplasm.

Formed—

Operation. (CAUSTIC Potash, 796.)

In chronic cases, complete antiseptics important.

ALCOHOL, in exhausting suppuration: and as lotion 1 to 4.

ALUMNOL as lotion, $\frac{1}{2}$ to 2 per cent., for irrigating, also as ointment, 403.

AMMONIUM Chloride solution injected in indolent cases, after withdrawal of some pus: internally in hepatic cases, 396.

BORIC Acid locally in powder, lotion, or ointment, 1 to 20, 298-9.

CARBOLIC Acid locally in powder, lotion, or ointment, and as irrigation, $\frac{1}{2}$ oz. to 20 oz.

COD-LIVER Oil.

CORROSIVE Sublimate, 2 $\frac{1}{2}$ gr. in 20 oz. for lotion or irrigation, 691.

CREOLIN, in 2 per cent. oily solution on absorbent cotton as dressing; also Izal.

IODINE tincture, 3 dr. in 20 oz., or IODOFORM emulsion, for injection into cavity, 94. (Drainage tube.) Iodoform poultice with linseed for fetid cases. IODIDES internally, especially STRONTIUM Iodide, as better tolerated.

HYDROGEN Peroxide (20 per cent.). Water equal parts, as antiseptic analgesic injection, good in mammary abscess, 23.

NAPHTHALIN used dry, or in alcohol or watery emulsion, 5-10 per cent.

POTASSIUM Permanganate, 10 gr. in 20 oz., specially when pus offensive, 759-99.

SALICYLIC Acid for irrigation: if cavity large 2 per cent. solution, cautiously.

ABSCESS (continued).*Formed (continued).—*

SULPHUR and SULPHIDES, especially that of Calcium, promote healthier action, 39.

TANNIC Acid dry, or with glycerin in lotion, to lessen discharge.

ZINC Chloride, 2 dr. in 20 oz. for irrigation, *cf.* 850.

ACIDITY.

Diet usually proteid, though extra-cooked starches often agree.

ACIDS, dilute, small doses before meals when tongue clean, 318.

ALKALIES and ALKALINE Earths, after or with meals; full doses for a short time relieve severe pain better than acids, 747, 801.

BISMUTH compounds often combined with preceding, 555. CHARCOAL, 28.

GREY Powder in $\frac{1}{2}$ gr. doses if motions light coloured.

IPECACUANHA, also NUX Vomica, especially during pregnancy.

PAPAIN, LACTOPEPTIN, if digestion slow and secretions deficient.

RESORCIN and other antizymotics: the same by lavage.

SILVER Salts, 463. VICHY water and lozenge, 229.

v. Dyspepsia, Pyrosis.

ACID POISONING.

Any ALKALI (not in effervescence).

ALKALINE Earths. Chalk. White-wash (scraped from wall or ceiling). MAGNESIA. Demulcents.

ACNE.

AMMONIUM Chloride in lotion with Alum, sometimes with sulphurated Potash, for chronic cases with comedones, 389.

ARSENIC sometimes in chronic indolent forms, and when of gastric, uterine, or bromic causation, 525.

BELLADONNA. BISMUTH Oleate, or lotion (not with Sulphur) for erythematous cases, 553.

BORAX and BORIC Acid as lotion, or additions to lotions, or the acid in strong spirituous solution, 1 dr. in 2 oz., 299.

BROMIDES, alkaline, in ointment, 1 to 5, for chronic cases, 137.

CARBOLIC Acid, strong, to spots, followed by collodion.

CAMPHOR with Sulphur and Lime-water in mucilaginous lotion.

ERGOTIN. ICHTHYOL as ointment, 20 to 50 p. c., and internally 5 to 20 gr. doses; also ichthyolates.

IODINE in decolorised paint to spots, especially menstrual cases, 96.

LEAD lotion lessens congestion, 779.

LIME Water with Rose water in chronic cases with erythema, 576.

MERCURY Perchloride in lotion, 1 to 2 gr. in 4 oz. of Almond mixture. Acid Nitrate solution for light touching of pustules, 696.

Purgatives generally necessary.

RESORCIN, in lotion, combined with Zinc oxide or Sulphur, or in paste, 30 gr. with 3 of Sublimate to 10 dr. of Zinc ointment mixed with 5 dr. of starch (Unna).

SOAPS with Camphor, Potash, Sulphur, Tar, etc.

SULPHUR in lotion or ointment, 1 to 4 dr., in 4 oz. of Elder-flower water, according to amount of erythema and irritation, 36; also as Ung. Sulph. iod. in indolent cases, 96, and Sulphide internally, 38.

ZINC Oxide lotion or ointment, sedative, astringent, also Sulphate, 850.

ACNE ROSACEA.

In this form, gastric irritation must be specially treated, and for reflex flushing, Antipyrin, Adrenalin, Bromides, Ergot, or Ichthyol are useful; locally scarification, electricity, alkaline, Lead or Zinc oxide lotions, hypodermic Alcohol \mathfrak{m} 30 twice weekly (Abrahams); also Bismuth ointments, or Collodion with Resorcin 15 gr., and Ichthyol, 30 gr. to the oz.

In chronic cases, Zinc sulphate with Potash sulphuret, 851; or Liq. Calcis sulphuratæ (diluted), 44; Sulph. hypochlorite, 37; or Mercurial iodide, 96. Lotions of Nitro-hydrochloric Acid, and foot-baths of the same, 343.

ACTINOMYCOSIS.

IODINE tincture locally. Iodides internally, 103. Surgical.

ADDISON'S DISEASE.

SUPRARENAL Gland (Medulla).

v. Anæmia, Vomiting.

ADENITIS. *v.* Lymphadenitis.

ADENOIDS.

Breathing exercises. Surgical (caution as to Chloroform).

AGUE.

AMMONIUM Chloride, adjunct to Quinine, 393.

ARSENIC specially for subacute and chronic cases of quartan type, 501; also CACODYLATES which are sometimes better borne, 531.

BIBIRU. BROMIDES for splenic enlargement, 154.

CINCHONA and its alkaloids.

EUCALYPTUS. HYDRASTIS. PHENAZONE. PODOPHYLLUM. SULPHITES, 378 (after Quinine). SALICYLATES.

Water drinking, affusion in tepid bath, cold douche, pack, 173-6.

ALBUMINURIA.

Generally dependent on Nephritis, *q.v.* Sometimes functional from malassimilation; or during adolescence, and for this form the treatment is rest and milk diet for a time: tonics, good food and exercise later.

If arising from congestive conditions, heart disease, pregnancy, over-exercise; or from disease of urinary tract *below the kidneys*, the particular treatment for such causes is required.

ALCOHOLISM.

AMMONIA in full doses, 1 to 2 oz. of solution of Acetate every $\frac{1}{4}$ hour, or dr. doses of the Spirit hourly, to steady the patient; also for the prostration, and as a substitute in drink craving, 391.

ANTIMONY, sometimes in delirium tremens, in the robust, 437.

ARSENIC, especially for the morning sickness, minim doses, 527.

BROMIDES for excitement, insomnia, and tremor, full doses, 151.

CANNABIS Indica. CAPSICUM. CHLORAL. CINCHONA. COCA (with caution as to habit). COFFEE. DIGITALIS. GOLD Chloride, 538-40.

HYDROCYANIC Acid as a sedative to the nerves of stomach, *cf.* 333.

HYOSCINE Hydrobromide, $\frac{1}{100}$ gr. by the skin for tremor and insomnia.

IRON, drachm doses of tincture for drink craving; also sulphate, 658.

KOLA. PILOCARPINE, $\frac{1}{2}$ to $\frac{1}{4}$ gr. by the skin. QUININE. STRYCHNINE. Water, cold pack or douche, or ice-bag to head, 207; also in sips as substitute for alcoholic drinks.

ZINC Oxide for tremor; also for the dyspepsia and debility, 854.

ALOPECIA.

AMMONIA with Oil, Rosemary and Honey-water, 388.

ARSENIC internally, small doses, 524.

CANTHARIS. CASTOR Oil, CINNAMON Oil, both locally. IODINE tincture as local stimulant, 97.

JABORANDI. NITRIC Acid, with sufficient oil, 338.

SULPHUR, antiseptic and stimulant, 36.

AMBLYOPIA. AMAUROSIS.

(May be functional from alcohol, tobacco, lead, quinine, hysteria, etc.) ARSENIC in climacteric cases. GOLD, double chloride, *cf.* 538. PILOCARPIN. STRYCHNINE. Vesication on the temple. (These may be combined.)

AMENORRHOEA.

AMMONIA, the liquor by vaginal injection, 388: the Acetate as capillary stimulant, the Chloride for debility and neuralgia, 395.

ACONITE in acute cases. ALOES.

ARSENIC for congestion and anæmia, 519. BORAX, 834. BARIUM Chloride, with Iron, 543.

CIMICIFUGA. COLOCYNTH. COCCULUS Indicus. CAULOPHYLLUM.

Electricity. ERGOT. GUAIACUM.

GOLD Chloride, for torpor, 537.

IODINE and IODIDES, for congestive, obstinate cases, 110.

IRON in anæmic chlorotic cases, 648. Chalybeate waters, 263.

Leeches to ovarian region or cervix.

MANGANESE, the Potash salt (Permanganate), or the binoxide (in 1 to 2 gr. doses), 761.

MYRRH. PENNYROYAL. PULSATILLA. RUE. SAVIN. SENECIO.

SULPHUR has some stimulating effect on weakly persons when used as a laxative, 43.

WATER, hot sitz and other baths to which mustard may be added, 216.

ANÆMIA.

ACID Hydrochloric dilute, in chlorosis with atonic dyspepsia, 319.

Alcohol, Red wine, etc.

ARSENIC in chlorotic and pernicious forms, and as an adjunct to Iron: also CACODYLATES, 508-31.

Baths, air, sea, moor, cold sponging.

CALCIUM Phosphate for certain forms, especially in children and after child-bearing; also hypophosphite and lactophosphate, 583-4.

CINCHONA and ALKALOIDS. COD-LIVER OIL. HÆMOGLOBIN.

IRON, non-astringent or organic compounds, with alkali or bitters if digestion is difficult, or by the skin; astringent preparations when tongue is flabby and secretions free, 644. Chalybeate Waters, 263.

MALTINE. MARROW, red.

MANGANESE, approved by some, but less so than formerly, 759.

NUX VOMICA. OXYGEN, 14. PHOSPHORUS in lymphoma, 65.

ANÆMIA, pernicious.

Besides the preceding, especially Arsenic and Bone marrow, disinfection of the mouth and intestinal tract should be secured by Salol, Naphthol, etc.

ANASARCA. *v.* Ascites. Œdema.**ANEURISM.**

BARIUM Chloride, adjuvant to rest treatment, 544.

CALCIUM Chloride, *cf.* 585. ERGOT.

IRON for anæmia, and has been used by injection, 633; now discarded.

LEAD Acetate, 781. OPIUM and alkaloids. PHENAZONE for pain.

POTASSIUM Iodide, increasing doses regulated by pulse, 107. Rest. Gelatine injection. Galvano-puncture. Surgical.

ANGINA PECTORIS.

During attack—

AMYL Nitrite by inhalation, or internally with spirit and glycerin; other Nitrites slower in action but more persistent, 839.

CHLOROFORM, ETHERS, AMMONIA, or BRANDY. OXYGEN, 14.

MORPHIA, by the skin. COCAINE.

ACONITE, CHERRY-LAUREL, PRUSSIC Acid, for palpitation, 334.

Mustard or other counter-irritants over chest. Galvanism from the nape or sympathetic nerve, to the sternum.

During intervals—

ARSENIC, which may be well combined with Iodides and Trinitrin, 512. BROMIDES, 148.

Diet and Hygiene. DIGITALIS. ERYTHROL Tetranitrate, 1-5 gr. doses 4-5 times daily, to prevent attacks; or Mannitol (hexanitrate), small doses (cheaper).

IODIDES relieve whether the case be syphilitic or not, 101.

PHOSPHORUS, 58. STRYCHNINE.

v. Heart disease, Dyspepsia.

ANKYLOSTOMIASIS.

THYMOL, 15 gr. in cachet, fasting, every 2 hours for 3 doses—followed by purge later.

v. Anæmia.

ANTHRAX.

CARBOLIC acid, locally and internally, *cf.* 369-74.

SUBLIMATE locally, internally, 711.

SULPHUROUS Acid and SULPHITES, locally and internally, *cf.* 369-74.

ANUS, FISSURE OF.

BELLADONNA, locally. BISMUTH ointment, 553. CALOMEL ointment.

CASTOR Oil or mild laxatives.

COCAINE locally. COLLODION.

CONIUM ointment. HYDRASTIS locally. ICHTHYOL, good with Conium.

IODOFORM, 118. OPIUM or its alkaloids.

POTASSIUM Bromide ointment or glycerin, 137.

SULPHUR internally, 42. TANNIN.

Surgical operation or dilatation.

AORTIC DISEASE.

For acute symptoms—

IODIDES, 100. MERCURIALS, 706-7.

SALINES (lessen blood pressure).

DIGITALIS for dilatation, cautiously. CAFFEINE as stimulant.

CHLORALAMIDE, MORPHIA (by the skin), DORMIOL, 15 m doses (pungent), or PARALDEHYDE, as sedatives.

In chronic cases—

ARSENIC, *cf.* 517. IODIDES. STRYCHNINE.

v. Angina, Heart disease.

APHONIA.

ACIDS, Nitric internally, Sulphurous in spray, 340-69.
 ALUM in spray, if due to local laryngeal conditions, 404.
 BENZOIN, CREASOTE, by inhalation.
 NITROUS Oxide (hysterical cases), 21.
 FARADISM to the neck or lightly to the vocal cords, in functional cases.
 SILVER Nitrate locally in relaxed, hysterical cases, *cf.* 457. STRYCHNINE often good with Valerian.
 ZINC Sulphate, in spray, 851.
 Surgical for growths. *v.* Hoarseness.

APHTHÆ.

ALUM, dry or in lotion (when the teeth are sound), 403.
 BISMUTH for tuberculous cases, 556.
 BORAX, 826. GLYCERIN. MEL.
 CARBOLIC Acid spray or paint.
 CALCIUM Chloride locally, also Chalk or Lime Water, 575-80.
 CHLORINE Solution or chlorinated Lime, $\frac{1}{2}$ dr. to 4-6 oz. of water with mucilage, 160.
 COPPER Sulphate lightly, or 10 gr. with honey 1 oz., 600.
 HYDROCHLORIC Acid dilute, 317.
 IODINE tincture dilute, as paint.
 MERCURY, Grey powder in small doses, *cf.* 710.
 POTASSIUM Chlorate and Permanganate, 799. SODIUM Chlorate, chloride or borate, 826.
 RHUBARB. SALOL. SALICYLIC Acid. SILVER Nitrate, to ulcers.
 SULPHUROUS Acid locally, diluted 1 in 8 or more, 369.

APOPLEXY.

ARSENIC, as prophylactic, 516.
 BROMIDES, *do.*, 153; also during convalescence, for general nervous conditions.
 Cold Water, Ice, to head or nape, 175-200. Counter-irritation.
 CALCIUM Chloride to prevent more hæmorrhage, 585 (not if thrombosis probable).
 IODIDES when acute symptoms have subsided, 102. MERCURY similarly.
 POTASH Acetate, and Nitrate, if thrombotic, especially if due to syphilitic arteritis, *cf.* 809.
 PURGATIVES, especially Calomel and Salines; also Croton oil and Elettarium.

APPENDICITIS.

APERIENTS (Calomel, Salts, or Oil) often indicated in early stages, enemata almost always.
 Hot applications, medicated for pain, 179. Leeches.
 Ice to lessen inflammation, 204.
 OPIUM, BELLADONNA, or other anodynes, but not so as to mask symptoms.
 SALICYLATE of SODA often relieves pyrexial cases.
 Operation so soon as pus formed or probable.

ARTHRITIS, RHEUMATOID.

ALKALIES in early stages, *cf.* 802-3.
 ARSENIC later, especially if skin dry and patient chilly, 508; also in bath, 501.
 CAPSICUM, CAMPHOR, and other stimulating liniments.
 CIMICIFUGA for pain.
 COD Oil and other fats.
 Diet (nutritious), Climate (equable). Galvanism. Hot air, 184. High-tension currents.
 GUAIACUM in chronic cases.
 IODIDES, generally with Iron, 644, or Arsenic, 101; Iodine locally, 90.
 LEAD lotion for inflamed joints.
 MERCURIAL ointment for frictions or strapping, 699.
 SALT, strong solution of, to affected joints on compress, 827.
 SALICYLATES not generally effective, unless for acute attacks for a short time.
 SULPHUR and Sulphur baths and waters, 42-274; also "Indifferent" Thermal, 221, Muriated, 248, and Iodobromated waters, 263.
 Vesication over roots or trunks of spinal nerves of affected parts.

ASCARIDES.

ACETIC Acid, dilute, in enema, 295.
 ARECA Nut powder, $\frac{1}{2}$ dr. for children. JALAP.
 CHARCOAL and SALT internally, a teaspoonful fasting, 29.
 IODOFORM in 1 gr. doses, 120.
 IRON Perchloride tincture, per rectum and internally, 660.
 LIME Water, by injection.
 MERCURY in ointment, or Perchloride solution locally.
 CALOMEL in purgative doses, 723.

ASCARIDES (*continued*).

SALT and Quassia injection, 828.

SANTONIN (best given with Calomel, Castor Oil, or Senna). SCAMMONY.

SULPHUR, 5 to 15 gr. night and morning, 43.

TIN, powdered, in electuary; now almost obsolete, 839.

ASCITES.

If from pressure of tumours—

Palliate only, or operate.

If syphilitic (e.g. from gumma in liver)—

IODIDES, 99; MERCURY, 718.

If cardiac in origin—

Improve heart compensation and tone. ARSENIC sometimes, 517, and IRON, 654. CAFFEINE. DIGITALIS. DIURETIN and its analogues (Theocin).

LACTOSE (sugar of milk) $\frac{3}{4}$ oz. to 1 pint of fluid, as diuretic.

MERCURY with SQUILL, etc., or CALOMEL, in small frequent dose as diuretic, 718. *v.* Heart.

If hepatic (usually cirrhotic)—

MERCURIAL purgatives, 718. IODIDES, 107. POTASH Bitartrate, 809. SALINE purgatives, 748.

If renal—

POTASH Citrate or Acetate, 810. APOCYNUM Cannabinum tinct. \mathfrak{m} 10-60; DIGITALIS—(both also in cardiac cases). IRON Acetate or Perchloride, 655.

Hot air baths, 181.

v. Nephritis.

If from chronic peritonitis (tuberculous usually)—

Operation; in any case paracentesis, if symptoms urgent.

ASTHMA.

During attack—

ALUM, 10 gr. may arrest it at commencement, 411.

AMYL Nitrite by inhalation, acts quickly but for short time.

APOMORPHIA, $\frac{1}{10}$ th to $\frac{1}{12}$ th gr. may arrest it at commencement, especially if bronchitic.

ANTIMONY and ARSENIC, especially in cigarette, 438-527.

BELLADONNA. CANNABIS COFFEE.

CHLORAL in full doses if heart normal. CHLOROFORM vapour. also in liniment to the chest.

COCAINE by spray or by the skin. Compresses hot, to chest and extremities. Counter-irritation over chest and spine and nerve-trunks.

COPPER Sulphate, in repeated doses till emesis occurs, 603.

Diet careful, not late meals.

DATURA Stramonium, D. Tatula, generally the leaves in powder burned, for spasmodic, not plethoric cases.

ETHER. ETHYL Iodide often with Chloroform.

EUPHORBIA Pilulifera, \mathfrak{m} 10 to 30 of tincture; 1 gr. of extract.

GRINDELIA Robusta. G. Squarrosa, burned with Nitre, and internally, fl. ext. 10-30 \mathfrak{m} doses.

HYDROCYANIC Acid in simple spasmodic cases, 334. HYOSCIN.

IODIDES, 105. HYDRIODIC Acid, 106.

MORPHIA in combination, or specially by the skin.

NITRE burnt on blotting paper, 806, or mixed with equal parts of powdered Aniseed and twice the amount of powdered Stramonium, sometimes also with Tea and Tobacco.

NITRITES, 806-37. NITROUS Oxide, 21. OXYGEN, OZONE, 10. The so called Ozone papers contain Nitre and Iodide, often Chlorate.

PHENAZONE, full dose at commencement, 5 gr. doses after.

PILOCARPINE. PYRIDIN vapour. Steam, medicated. SUPRARENAL GLAND, 5 gr. every 2 or 3 hours (or ADRENALIN). TOBACCO.

In the intervals of attacks—

The preceding may most of them be used in smaller doses continued, or combined, *e.g.*: ARSENIC with Iodides or Hydriodic Acid, 806, Belladonna, and Ipecacuanha; also ALKALIES and Alkaline mineral waters, especially in bronchitic cases, 229.

BROMIDES, especially in chronic cases; also fumes of the Ammonium salt, 148.

Breathing exercises, especially deep inspirations. Compressed air, 11. Galvanism, sometimes Faradism, of the Vagi. Ice to the same nerves. Nasal mucous membrane (septum), cautery of.

ASTHMA (*continued*).

In the intervals of attacks (contd.)—

SILVER Salts internally, in markedly neurotic cases, also locally (to larynx), 469.

SULPHUR, 41: Sulphurous acid, and Sulphur waters, in spray, vapour and internally, 274-369.

ZINC Salts, prophylactic, 854.

For cardiac and renal cases, see suitable headings.

ATAXY, Locomotor (and other forms).

ALUMINIUM Chloride (3 gr. thrice daily), to lessen pains, 410.

ARSENIC, also in functional cases, choreic, postfebrile, etc.

ERGOT, especially for urinary derangements.

GOLD Chloride with Sodium, $\frac{1}{10}$ gr. thrice daily well alternated with Arsenic, 538.

IODIDES in full doses, especially, but not only, in syphilitic cases, 102.

IRON Lactate with Cinchona and Nux Vomica (Erb).

MERCURY Perchloride, sometimes a good alternative treatment.

METHYLENE Blue, 1 to 3 gr. doses, for pains.

Movements, systematic (Fraenkel).

PHENAZONE and similar anodynes for gastric crises, etc.

SALINE solution or SPERMINE injections. SALICYLATES.

SILVER Salts often beneficial, 467.

Suspension sometimes useful for pain and bladder symptoms, also forcible flexion of thighs on abdomen (to stretch cord). Counter irritation if spine tender, and in gastric crises. Galvanism over spine.

For complications *v.* Cystitis, Neuralgia, Paralysis, Syphilis, etc.

ATROPHY, MUSCULAR. Idiopathic—Spinal progressive (wasting Palsy, Polio-myelitis).

ARSENIC, often with GOLD Chloride, 538. IODIDES, 102. STRYCHNINE (into wasted muscles). Faradism (if reaction to it). Galvanism. High-tension currents. Massage.

ATHEROMA.

ARSENIC improves nutrition and peripheral circulation, and lessens anginal pain, 517.

PHOSPHORUS, *do.*, *do.*, *cf.* 59.

BALANITIS.

ALUMNOL as dusting powder, 403.

BORIC Acid lotion, 1 part in 20, 298.

COPPER Sulphate lotion, 1 gr. to 1 oz., 60. LEAD lotion, 778.

LIME Water as lotion, 576.

MERCURY, as blackwash, or calomel dusting powder, *cf.* 695.

POTASH Permanganate, $\frac{1}{2}$ gr. to 1 oz., *cf.* 798. SILVER Nitrate, solid stick lightly, or lotion, or ARGYROL, 2 to 5 per cent., 454.

Surgical (dilatation of prepuce).

ZINC Sulphate or Sulphocarbolate, 1 to 2 gr. to 1 oz., 851.

BALDNESS.

v. Alopecia.

BEDSORE.

Preventive—

Water bed. Harden skin with Spirit lotion (better if mixed with Alum and white of egg), *cf.* 403; or glycerin of Tannin. Protect with powder, plaster or Collodion.

Curative—

BISMUTH in powder, cream or ointment, with Friar's or Peruvian balsam.

BORIC Acid ointment, 299.

CHARCOAL in powder or poultice if sore offensive, 28.

CHLORAL in lotion. HYDRASTIS, *do.*

IODOFORM powder or ointment for certain stages, 116.

LEAD, the liquor as paint, sometimes with an astringent, as Catechu, *cf.* 778.

RESIN ointment with Peruvian balsam, equal parts.

SILVER Nitrate in solution, 5 to 10 gr. to 1 oz., sometimes in powder to sluggish sores, 455. Thin Silver over ulcer, connected by wire to Zinc on skin (Bird).

ZINC Salts, in various forms, often with antiseptics, balsams, or camphor, 350-851.

v. Ulceration.

BERI-BERI.

Diet (not rice (?)). Climate, change of. **BELLADONNA**. **SILVER Nitrate**. **SALICYLATES**. Disinfection.
v. Neuritis.

BITES, Poisoned.

AMMONIA, dilute solution locally, internally or by the veins, 389.
CHROMIC or **NITRIC Acid** as caustic, 309-336.
POTASH solution locally, internally, and by the veins. **Permanganate**, for bathing and injection, 758, 799.

BLADDER, Irritable.

ACIDS or **ALKALIES** as indicated.
AMMONIUM Citrate, 397. **BELLADONNA**. **BENZOIC Acid** and compounds. **CAMPHOR**. **HENBANE**. **LINSEED**. **LYCOPodium Tr.** m 20-60.
v. Prostatitis, Cystitis, Calculi.

BLADDER, Atony of.

ARNICA. **CANTHARIDES**. **COCCULUS**. Catheterism. **ERGOT**. **NUX**.
v. Paralysis.

BLADDER, Catarrh of.

v. Cystitis.

BLEPHARITIS (Tinea Tarsi).

ARSENIC in strumous cases, 506.
BISMUTH ointment or glycerol, 553.
BORIC Acid, or **Borax** in lotion, 2 to 6 gr. in 1 oz., 297.
CALCIUM Sulphide, 39. **Cod Oil** and Tonics.
COPPER Sulphate lightly after cleansing, 600. **HYDRASTIS** lotion.
IODINE tincture locally, 95.
LEAD Acetate lotion warm, 779.
MERCURIAL lotions, or ointments of **Calomel**, **Oxide**, etc., 703. **TANNIN**.

BOILS.

To abort, or in early stages—

Puncture of inflamed skin, or epilation. **ALCOHOL** in compress.
BELLADONNA extract with glycerin as plaster.
CHLORAL 1 in 4, as compress.
CARBOLIC Acid, 5 per cent. in injection or paint.
COCAINE similarly. **COLLODION**.

ICHTHYOL, or **Thiol**, 1 in 4, as varnish. **IODINE** tincture painted round, or dilute in compress, 85. **IRON Oleate**, 349. **MERCURIAL** ointments or lotions, 711. **SALICYLIC Acid** plaster.
SILVER Nitrate, 1 in 8, as paint; also the oleate, 350.
SODIUM Phosphate or other saline purgative, 833.

If pus has formed—

Some of the preceding still useful, also hot fomentation or poultice (not overmuch).

IODINE tincture, a few minims injected.

LIME Water compress checks inflammation, and hastens suppuration, 576. **LIME Sulphide** in lotion, and internally in small frequent dose, 39.

Operation. Strapping.

If suppuration free and boils many—

ACID tonics, with **Bark**, cf. 340.

CARBOLIC Acid and other antiseptics locally. **IRON**, cf. 636, with **Arsenic** or **Potash chlorate**, 800.

SULPHOCARBOLATES, **SULPHITES**, 374. **SULPHUR Waters**, or **Sulphur**, 5 to 10 gr. night and morning.

YEAST, fresh, in 1 dr. to $\frac{1}{2}$ oz. doses; also in poultice.

BONE DISEASE.

v. Caries, Osteomalacia, Fracture.

BRAIN DISEASE.

v. Apoplexy, Congestion, Meningitis.

BRIGHT'S DISEASE. v. Nephritis.**BROMIDROSIS.**

v. Perspiration, local.

BROMISM.

ARSENIC inhibits eruptions, 140.

Stimulants, including coffee.

SODIUM Chloride quickens elimination, 137.

STRYCHNIA, antidotal, 136.

BRONCHIECTASIS.

ALLIUM (garlic) chopped, $\frac{1}{2}$ dr. in cachet, or juice $\frac{1}{2}$ dr., or syrup (U. S. P.) 1 to 4 dr.

BRONCHIECTASIS (*continued*).

CARBOLIC Acid internally, also by spray or vapour.

CREASOTE do. (*cf.* B. M. J., i., 1895).

CHLORINE, 162. EUCALYPTUS. IODINE, 105. MENTHOL. TAR. THYMOL. TURPENTINE or TEREBENE.

SULPHOCARBOLATES or SULPHITES internally, disinfect sputum, *cf.* 374.

ZINC Oxide or Sulphate, 853.

BRONCHITIS.*Acute—*

ACONITE to lessen pyrexia and soreness of chest, and promote skin action.

ALKALIES, especially Potash and Ammonia salts, to thin and help expectoration, 393; generally combined with preceding, or with ANTIMONIAL Tartrate, in small frequent continued, or in occasional emetic doses, especially for capillary forms; must be used with extra caution in children, 430.

HEROIN or MORPHIA in small doses sometimes added, but not for children. IPECACUANHA often with preceding, or in emetic doses for children.

LINSEED, or linseed-mustard poultices. Liniments. Purgatives.

OXYGEN, 14. PILOCARPINE.

Steam inhalations or spray.

Venesection in some congestive cases with cyanosis, or Cupping between the shoulders.

Subacute (Bronchial Catarrh)—

AIR, compressed, 11.

AMMONIUM Carbonate or acetate; also Chloride and vapour, 393-4.

ANISEED.

APOMORPHIA as expectorant.

BELLADONNA. CAMPHOR. HYOS-

CYAMUS. CHLORAL HYDRATE.

CHLOROFORM Spirit. CONIUM.

IPECACUANHA (spray).

LIQUOR Potassæ, Potash salts, 806.

IODIDES, generally of Ammonium or Potassium, augment, thin, and facilitate expectoration, 105.

MORPHINE, Codeine, Heroin, or Opium, sufficient to soothe cough if expectoration is free enough, generally combined with stimulating expectorants, as in Tr. Camphoræ co.

LOBELIA. NUX. SENEGA. SQUILL.

SUMBUL. VIRGINIAN PRUNE.

Chronic—

ACIDS, Nitric, Nitrohydrochloric, when secretion free and debility marked; used also diluted for sponging chest, 341-3.

ALUM in some cases with copious viscid sputum, 411.

AMMONIA and other expectorants and sedatives as in subacute cases. Ammonium Chloride internally and in vapour, 393 4.

ARSENIC, especially when emphysema developed (cigarette), 527.

AMMONIACUM. BALSAMS of Tolu and Peru. CARBOLIC Acid vapour. CARBONIC Acid gas, 306. COPAIBA. CUBEBS. EUCALYPTUS.

BRONCHOCELE.*Cystic—*

Enucleation. Incision. Tapping. Injection of Chromic acid, 303.

In Cretins—

THYROID feeding or extract.

Soft fibroid, fibro-cystic—

Blister. Seton. Electrolysis. Surgical.

BARIUM Chloride, 543. BROMIDES, 154 (Kreuznach, Woodhall).

CADMIUM Iodide ointment, 562.

IODINE, IODIDES, locally and internally, 85, 109.

IODIFORM wool, ointment, or emulsion injected, 118

MERCURY, red iodide ointment, 698.

SODIUM Phosphate in large doses continued, is said to cause atrophy of goitres (Zakzewski).

BRUISE.*Before ecchymosis*, cold lotions with

LEAD, 778, AMMONIUM chloride, 389, or Spirit, to which OPIUM and other anodynes or ARNICA may be added. *Later*, the same warm, applied with pressure; also CAMPHOR, OIL of BAYS. Massage. *v.* Sprain.

BUBO.

CALCIUM Sulphide in indolent cases, but not so helpful as in ordinary abscess, 39.

CARBOLIC Acid with Iodine as paint, or in lotion, after operation.

BUBO (*continued*).

- COPPER Sulphate as injection after incision, 602.
 CHLORINE solution as disinfectant lotion, 160.
 Ice sometimes in early stages.
 IODINE as paint or injection, 94.
 IODOFORM, *do.*, 117.
 IRON and Tonics for anæmia and debility.
 LEAD lotion continuously, 778-80.
 MERCURY—ointment or oleate by friction or as paint; Sublimate solution for washing out, 698.
 NITRIC Acid, applied lightly over torpid suppurating buboes, 337.
 PEROXIDE of HYDROGEN, 4 per cent. solution as antiseptic lotion, 23.
 POTASH, Caustic, used formerly to open by slough, 796.
 Water, cold in early stages, hot later. Rest and treatment of cause. Surgical.

BUNION.

- IODINE painted on when indolent.
 LEAD lotion when inflamed, 778.
 Strapping. Special socks and boots.
 Operation.

BURNS AND SCALDS.

- ADEPS. ALUMINIUM Oleate ointment, 349.
 BISMUTH, 10 per cent. ointment for irritable discharging surfaces, 552.
 BORIC ointment or lotion, 298.
 CARBOLIC Acid lotion. Collodion.
 Cotton wool. Baths, prolonged, 191.
 COCAINE, 2 per cent. for pain, if cuticle removed.
 GLYCERIN a good early application.
 IODINE Tr. or ointment in burns of first degree with unbroken skin, 96.
 IODOFORM for the suppurative, not the acute stage, 116.
 LEAD Acetate with Lime water, or Carbonate with Oil, in acute, 779.
 LIME Water with Oil (*Lin. Calcis*), 577. OPIUM for pain.
 OXYGEN applied in jet or enclosed, for chronic ulcerations, 8.
 PICRIC Acid, saturated solution—(possible risks from absorption).
 POTASH Permanganate, 1 to 2 gr., Chlorate, 5 gr. to the ounce, as lotion, or Nitrate in bath, 797.
 SOZOIODOLATES, 10 per cent. in powder with starch, *etc.*

- SALICYLIC Acid, 2 per cent. in oil.
 SILVER Nitrate solid, or in solution in water or oil, 460.
 SODIUM Bicarbonate or borate, saturated solution, relieves burning pain, and prevents vesication, if applied at once, 827.
 Stimulants for collapse.
 TURPENTINE to superficial burns, pains at first, relieves later.
 ZINC Oxide and Carbonate for acute, Sulphocarbonate or astringent salts in solution for indolent, suppurative stages, 851.
v. Ulceration.

CALCULI, URINARY; also deposits.

- ACIDS, Phosphoric, Hydrochloric, or Nitro-hydrochloric, in cystine, oxaluric, and phosphatic cases, 339.
 ALKALIES as solvents for uric acid deposits, 802-30.
 Alkaline Waters, 229.
 BENZOATES of Ammonium, Sodium, Calcium in phosphatic cases, 397.
 CALCUSOL, *i.e.* Potash bicarbonate with Piperidine benzoate, 802.
 LIME Water and lime carbonate in uratic cases, 586.
 LITHIUM Salts, especially bromide and benzoate *do.*, and as injection; also Thialion, 737-8.
 MAGNESIA as antacid solvent, 751.
 MORPHIA and other anodynes (suppository). Anæsthetics.
 Water hot, distilled, as diluent.
 Surgical.

CANCER.

- ACIDS, Chromic, 309; Nitric, 337; Sulphuric, 360; as local caustics.
 ARSENIC as a caustic in paste for superficial cases, 500; also internally, 526.
 BROMINE by injection into growth, especially if uterine, 125.
 CALX with Potash as caustic, 573.
 Liq. Calcis and Chloride as local applications for discharge, *etc.*—Carbonate internally, 584.
 CARBOLIC Acid, disinfectant lotion.
 CARBONIC Acid locally applied relieves pain, 305.
 CHARCOAL in poultice as antiseptic and detergent, also internally, 28.
 CHLORAL. CONIUM. BELLADONNA.
 COLEY's fluid and other sera.

CANCER (*continued*).

COPPER Arsenite with mucilage, as escharotic and disinfectant, 601.

ETHYLATES. EUCALYPTUS.

FORMALIN, 2 per cent. solution on lint applied every 6 hours for 3 to 7 days. GOLD Chloride as caustic, 536. HYDRASTIS.

IODOFORM as deodorant and to lessen discharge, 117.

IRON Perchloride locally for hæmorrhage, etc., 630.

MERCURY Perchloride or Sulphide in paste or injection locally; acid Nitrate as paint for epithelioma, 701.

OPIUM, or its alkaloids. PAPAIN, PEPSIN locally.

POTASH, Caustic, 797.

RESORCIN, or SALICYLIC Acid pastes.

SILVER Nitrate, weak injections into growth, 451. Surgical.

X-Rays for superficial growths and for pain. ZINC Chloride and Nitrate, caustics, 848.

CANCER of STOMACH.

CONDURANGO, Ext. liq. $\frac{1}{2}$ dr. doses.
v. Gastric catarrh and ulcer.

CANCERUM ORIS.

ACIDS, Nitric, Hydrochloric, Sulphurous, locally, 317-36-69.

AMMONIA (with Bark) internally.

ARSENIC internally as in other ulcerations, 526.

CALCIUM Chloride, Lime water, 575.

MERCURY with chalk in small doses, 710. Sublimate lotion, weak, *cf.* 703.

POTASH Chlorate, Permanganate, 799. PYOKTANIN, in 1 per cent. solution.

v. Aphthæ.

CARBUNCLE.

CARBOLIC Acid, 1 in 10 of glycerin and water for injection, 1 in 50 for spray.

OPIUM. Strapping. Surgical.
v. Boil, also Abscess.

CARDIAC Disease.

v. Heart.

CARIES.

ACIDS, especially Sulphuric, half water, locally applied, 360.

BENZUIN tinct. comp. for sinuses.

CALCIUM, especially Phosphates, 580.

COPPER Sulphate as "liquor Villati," locally, 602.

GOLD Chloride in "scrofulous" cases, internally, 537.

IODINE as injection, *e.g.* in psoas abscess, 94. IODOFORM, 119.

IRON with iodine, alterative tonic, 660.

MINERAL waters and baths, especially Saline, Sulphur, 220-1; Sea-, 213 (Margate); Kreuznach, 254; La Bourboule, 271.

PHOSPHORUS, internally, 64; Phosphoric acid dilute, 1 in 8 locally.

CATARRH.

Acute nasal or bronchial—

ACONITE. ADRENALIN, locally.

AMMONIUM Acetate or Carbonate, sometimes Iodide, 393-4.

ANTIMONY sometimes, in markedly febrile cases, *cf.* 428.

Baths, hot, vapour, Turkish, 180-1.

BELLADONNA. BENZOIN vapour.

BISMUTH compound powder as snuff, 553. BORAX in spray, gargle, or compound lozenge, 825.

CAMPHOR. CARBOLIC Acid. CHLORAL. COCAINE. CREASOTE.

CUBEBS. EUCALYPTUS.

GREY Powder in small frequent dose, 709.

IODINE vapour with Camphor or Carbolic Acid, 95.

IPECACUANHA.

LINSEED. MUSTARD. MENTHOL. NITROUS ETHER. OPIUM.

POTASH Chlorate, also Nitrate, with Dover's powder, 806.

QUININE. SALICYLATES.

SULPHUR, SULPHUROUS Acid, vapour or spray, 369.

Chronic (post nasal)—

Remedies as above, also Ammonium Chloride in vapour and internally, and as nose-wash 5 per cent. if discharge thick, 394.

ALUM, in powder or douche.

ARSENIC internally for profuse secretion and sneezing, 526.

BROMINE inhalations, 125.

MINERAL Waters in spray, Ems, La Bourboule, etc., 234-71.

Operation for adenoids, etc.

SILVER Nitrate, weak in douche, stronger as paint, 456. TERE-BENE, vapour and by the mouth.

CATARRH (*continued*).

Water, especially salt, in gargle, compress, or bath, as prophylactic, 193.

v. Gastric Catarrh, Diarrhœa.

CHANCRE.

BROMINE has been sometimes used as caustic, 125.

CARBOLIC Acid, strong, do., early, once over surface of sore.

CHLORINE solution, or chlorinated Soda, 1 part in 12, as lotion, 160. HYDROGEN Peroxide in lotion, 10-15 per cent., 23.

IODOFORM and congeners, *e.g.* Aristol in powder or ointment, 117.

LEAD Acetate in lotion, 773, with Carbolic, etc.

MERCURY in various forms, locally and internally, 700-13.

NITRIC Acid in phagedænic cases, or where caustic is suitable, 336.

SILVER Nitrate, do., 452.

ZINC Chloride or Nitrate, do., 849. *v.* Syphilis.

CHAPPED HANDS, LIPS, NIPPLES.

BISMUTH Oleate or ointment, with tinct. Benzoin, 553.

BORAX, a weak lotion of, 826.

Collodion. Glycerin, with Rose water and Tr. Benzoin co. or Hydrastis. Cold Cream. Vaseline.

LEAD lotion with glycerin.

LINSEED infusion for washing.

MERCURY as grey powder or locally in ointment, *e.g.* white precipitate 12 gr. to the oz. with liq. Picis Carbonis, 40 m.

SILVER Nitrate followed by fomentations. ZINC Oleate or ointment. *v.* Eczema.

CHILBLAINS.

Unbroken—

ALUMINIUM Oleate, 349.

BELLADONNA liniment with Chloroform.

BORAX and Boric acid with glycerin, 299. CALCIUM Sulphide internally, also Chloride, 580. Carbolicised glycerin.

CAMPHOR Spirit or compound liniment with Tr. Capsici, Tr. Cannabis, Ol. Cajepūt āā 3ss in 3i: apply with friction.

EUCALYPTUS Oil with Menthol.

Hot bathing plus Faradism.

IODINE tincture, or ointment, 96.

IRON with Arsenic internally to improve circulation.

LEAD lotion or ointment, 779.

SALT, strong solution of, 826.

SULPHUROUS Acid, compress or spray, 368.

TURPENTINE with Olive oil.

Broken—

ICHTHYOL, 20 per cent. ointment.

ODOFORM, 116. RESIN ointment. ZINC do., with Benzoin. *v.* Ulceration.

CHLOROFORM POISONING.

AMYL Nitrite.

Artificial respiration, etc. The Konig-Maas method is to press firmly and rapidly over the heart apex region. Laborde draws forward the tongue 20 times per minute.

OXYGEN, 9. Venesection.

STRYCHNIA by the skin.

CHLOROSIS.

ARSENIC, 507. IRON, 648.

Digestives. Purgatives. Galvanism. Massage.

v. Anæmia; also Amenorrhœa.

CHOLERA, CHOLERAIC DIARRHŒA.

ACID, Sulphurous, fumigation, 373.

ARSENIC solution, 5 minims every hour or two, till improvement: infants, 1 minim, 523.

BISMUTH, sometimes with Opium, or full doses twice daily, 557.

CAJEPUT. CAMPHOR. CAPSICUM. CARBOLIC Acid. CATECHU. CHLOROFORM. COTOIN, 1 to 2 gr. doses.

CASTOR Oil as eliminant for 1 or 2 doses, then 2-3 minims with mucilage and anodynes—repeated.

COPPER Sulphate internally; metal fumes as prophylactic, 605.

ICE recommended for thirst, but by some found dangerous.

IRON Pernitrate, 657, also with Quinine and adjuvants. KINO.

LEAD Acetate, 782 (after securing elimination).

MERCURY Subchloride, in small dose frequently (with Piperine) 722, also the Perchloride, 721.

CHOLERA, etc. (*continued*).

OPIMUM in small dose only, and not in early stage.
 PODOPHYLLIN to promote bile secretion. SALOL.
 SODIUM salts, especially Chloride by intravenous or other injection, 825.
 STRYCHNIA and heart stimulants for collapse. ETHER. Warmth.
 TANNIN, Tannalbin (Tannigen, etc.), sometimes by irrigation, 2 oz. to 1 gallon (hot).
 Water in various forms of pack and compress, 205, and as drink, 209.

CHORDEE.

ACONITE. BELLADONNA. CHLORAL. BROMIDES, 149. CAMPHOR. CANNABIS Ind. OPIUM. PHENAZONE. Enemata warm Suppository of Morphia, Belladonna, and Camphor.

CHOREA.

ANTIMONY tartarated, used formerly for the sedative nerve effect following nauseant doses, 438.
 ARSENIC, especially for simple cases in quickly increased doses, or in complicated cases combined with anti-rheumatic medicines, or Bromides for excitement, Iron for anæmia, 513. CACODYLATES, 532.
 Baths, warm, affusion, douche. Rest.
 CALABAR Bean. CANNABIS Indica. CHLORAL. CHLOROFORM. CIMICIFUGA. COCCULUS. CURARE.
 CONIUM, full doses in obstinate cases.
 COPPER Sulphate, especially if worms present, 602.
 ERGOT in full doses as sedative.
 ETHER spray to spine sometimes soothes. Galvanism, moderate.
 HYOSGIN.
 POTASH Carbonate in bath, Iodide internally, 102.
 QUININE. SALICIN. SALICYLATES. SILVER Nitrate, 469. STRYCHNINE in chronic cases. TIN Chloride has been used in the same, 840.
 TRIONAL. VALERIAN.

CHEIRO-POMPHOLYX.

ARSENIC, later Iron and nerve-tonics. Soothing, astringent remedies locally.
v. Eczema.

CHOROIDITIS.

v. Iritis.

CHYLURIA (mostly from Filaria).

BENZOIC Acid and compounds.
 IODIDES in full doses.
 IRON Perchloride useful even in very chronic cases, 656.

CINCHONISM.

BROMIDES. HYDROBROMIC Acid, 311.

CIRRHOSSIS OF LIVER.

POTASSIUM, Acid tartrate of, in alcoholic cases, 809.
v. Ascites, Congestion (hepatic), Hæmatemesis. Vomiting.

CLIMACTERIC.

ARSENIC, especially in uterine congestion, 513.
 Baths in various forms, 174-5.
 BROMIDES for ovarian congestion, unrest, flushing, headache, etc., 145.
 CAMPHOR. NUX Vomica.
 IRON Perchloride with the above, for weak anæmic subjects, 658.
 ZINC Oxide, Phosphide, and Valerianate, especially with other medicines, 854-5.
v. Hysteria. Menorrhagia.

COLD.

v. Catarrh.

COLIC, INTESTINAL.

APERIENTS, Castor-oil with a little opium. Calomel with a little morphia. Magnesia, 748. Rhubarb with aromatics. Enema, stimulating Fomentations with Turpentine, or other forms of heat.
 AMMONIA, 395. ASAFCETIDA. BELLADONNA. CARDAMOMS and other aromatics. CHLOROFORM. ETHER.
v. Calculus, Cholera, Constipation, Flatulence, Plumbism, Worms.

COLITIS.

BISMUTH. OPIUM. Lavage of colon.
v. Diarrhoea.

COLITIS, MEMBRANOUS.

Diet. Antiseptics, especially SALOL.
 Lavage of colon (Plombières).
v. Dyspepsia, Constipation.

COLLAPSE.

Affusion or pack, warm, 176.
 AMMONIA (mouth or injection), 390-1.
 Electricity. Stimulants.
 STRYCHNIA or TRINITRIN by skin.
 SALINE injection, *cf.* 825.

COMA.

v. Alcoholism, Apoplexy, Diabetes,
 Meningitis, Uræmia.

CONDYLOMA.

CALOMEL (with Zinc oxide) as dusting
 powder, or the acid Nitrate, 700.
 CHROMIC Acid, 1 in 5 (on tongue), 308.
 IODOFORM, 117.
 SALICYLIC collodion.
 SILVER Nitrate, 451-2.
 ZINC Chloride and Nitrate, 849.

CONGESTION.*Cerebral—*

ARSENIC, prophylactic, relieves
 giddiness and a sluggish venous
 circulation, 517.

BROMIDES, especially when heart
 action is forcible, 153.

Counter-irritation. Leeches.

COLOCYNTH. CROTON Oil. JALAP.

DIGITALIS. ERGOTIN. GELSEMIUM.

MERCURY, more used formerly as
 in meningitis, now chiefly as
 purgative, and combined with
 other purgatives, 705-20.

Massage especially of neck and
 limbs. Water in various forms:
 foot baths, compresses, etc., 206.

Hepatic—

ACIDS, Nitric, 339, Nitro-hydro-
 chloric, 342, internally (often
 with Bitters) and in bath in
 subacute and chronic cases.

AMMONIUM Chloride, especially
 when lithæmia, or bile-suppres-
 sion, and in passive cases, 396.

CHLORINE solution said to stimu-
 late bile secretion; and Chlorine
 in vapour baths, 162.

Counter-irritation. Leeches.

Exercise. Galvanism.

EUONYMIN. HYDRASTIS. IPECAC-
 UANHA. IRIDIN.

MANGANESE sulphate as purgative,
 761, generally with MAGNESIAN
 sulphate, and other compounds,
 especially in mineral waters,
 Compound Soda, 237, Salt, 248,
 Bitter, 244, Sulphur waters, 274.

MERCURY in alternative or pur-
 gative doses, 720. NUX Vomica.
 OX-GALL. OXYGEN by inhala-
 tion, or as fresh air.

PODOPHYLLIN. RHUBARB.

SODIUM Salts, phosphate, sul-
 phate, salicylate and in Mineral
 waters—Vichy, Carlsbad, Brides,
 etc., 219-830.

SULPHUR in chronic cases with
 enlargement of liver, hæmor-
 rhoids, etc., 42. TARAXACUM.

Water in various applications and
 baths, 204, Turkish baths.

Laryngeal—

ACONITE tincture in acute cases.

ALKALIES internally and in spray.

ANTIMONY tartarated, 434. BEN-

ZOIN vapour. CARBOLIC Acid, *do.*

Counter-irritation externally; com-
 presses. Steam, medicated.

SILVER Nitrate locally, 458.

TANNIN. ZINC Sulphate spray,
 851.

Pulmonary—

v. Catarrh, Phthisis, Pneumonia.

CONJUNCTIVITIS.

ALUM curd, poultice or lotion, 404.

BISMUTH glycerole for chronic gran-
 ular cases, 553. COCAINE.

Blister to temple or mastoid.

BORAX or Boric Acid in drops or
 lotion, 2 to 6 gr. in the ounce, 299.

HYDROGEN Peroxide, in weak solu-
 tion, especially if pus formed, 24.

IODINE liniment painted round the
 orbit, or behind ears, relieves
 photophobia, 95.

LEAD lotion warm, very serviceable,
 unless the surface is abraded, 779.

MERCURIAL ointments, weak; Sub-
 limate irrigations in contagious
 cases, 703.

PHOSPHORIC Acid internally in stru-
 mous cases, 355.

SILVER Nitrate sometimes in chronic
 cases, 456; organic silver salts, 441.

ZINC Sulphate in warm lotion, 1 to 2
 gr. to the ounce, 851.

CONSTIPATION.

ALUM has been used in 20 to 40 gr.
 doses, but is not satisfactory, 408.

ALOES, often with Iron in anæmia,
 debility, and amenorrhœa, etc.

ANTIMONY in small doses in some
 cases as adjuvant, 436.

CONSTIPATION (*continued*).

BELLADONNA generally as adjunct or with NUX.

BORIC Acid applied to rectum or insufflated, in torpor of colon, 299.

ALMOND, OLIVE, CASTOR or CROTON Oils. CASCARA. COLOCYNTH. ELATERIUM. EUONYMIN.

Diet—vegetables, fruit—Fig, Prune, Tamarind, etc.

GAMBOGE. GLYCERIN. HYDRASTIS. IRIDIN. LEPTANDIN.

IPECACUANHA as adjunct. LIQUORICE Powder, compound. MANNA.

MAGNESIA fluid, citrate, sulphate, 747.

Massage and electricity to abdomen.

MERCURY in various forms and doses, especially in febrile or high-tension cases, or when signs of liver derangement, 720.

NITRIC Acid in full doses, especially with bitters 340. NUX. PHYSOSTIGMA. PODOPHYLLIN.

POTASSIUM Sulphate or acid Tartrate, generally in combination (Rochelle salt), 809.

PURGING FLAX. RHUBARB. SALINE bitter waters, 244. SCAMMONY. SENNA.

SODIUM Sulphate, Phosphate, or Tartrate (Seidlitz), 833.

SOAP introduced into rectum or added to enema.

STRYCHNINE as adjunct.

SULPHUR, especially when hæmorrhoids or rectal congestion, 42.

Water in various ways, enema, compress, douche, morning draught.

CONSUMPTION. *v.* Tuberculosis.

CONVULSIONS.

Infantile—

AMYL. BELLADONNA.

BROMIDES during dentition, also in meningitis, 143. CHLORAL.

CALOMEL purge. Cold to the head, 206-8. Mustard frictions and bath, 216. Water in various forms of pack, bath, and vapour bath. 176-80.

v. Worms.

Puerperal, Uræmic, etc.—

As above, also ANTIMONY, 437.

v. Epilepsy. Nephritis. Congestion, cerebral.

CORNES.

ACETIC Acid, glacial, after paring, 295.

IODINE tincture relieves pain and congestion.

NITRIC Acid, in conjunction with knife, 338.

SILVER Nitrate, do., do., 451.

PAPAIN solution, 1 in 10. SALICYLIC Acid, 1 in 8 (usually with Colodion, Ether and Cannabis), or in plaster.

SULPHUROUS Acid on lint, 368.

THUJA tincture, applied thrice daily.

CORYZA.

v. Catarrh.

COUGH.

v. Catarrh, Bronchitis, Pertussis, Throat, relaxed, etc.

CRAMP.

Intestinal—

v. Colic.

Muscular—

Change of position. Warmth.

Friction with anodyne liniments.

If from overfatigue, rest; from anæmia, Iron.

If from defective elimination, massage, Salicylates, vapour bath.

v. Dyspepsia.

CRETINISM.

Thyroid feeding.

CROUP.

Catarrhal—

ACONITE. BELLADONNA.

ALUM as emetic, drachm doses, 410.

AMMONIUM Carbonate in later stages, as stimulant and expectorant, 393. AMYL NITRITE.

ANTIMONY, small doses cautiously, expectorant, sedative, 434.

Counter-irritation over larynx.

IPECACUANHA. LACTIC Acid in spray, 1 in 12 to 16. LOBELIA.

POTASH solution and various salts, thin and help expectoration, 806.

SQUILL. TRINITRINE, $\frac{1}{2}$ tablet ($\frac{1}{300}$ th gr.) every $\frac{1}{4}$ hour till spasm relieved.

Water, as hot fomentation and steam, medicated with Carbolic, Eucalyptus, etc.

ZINC Sulphate, 10-20 gr., with plenty of warm water as emetic.

Membranous—

v. Diphtheria.

Spasmodic—

v. Laryngismus.

CYANIDE POISONING.

Stimulants. Oxygen, 9. Atropine, 331.

CYSTITIS.

ACID PHOSPHATE of Sodium readily acidifies alkaline urine.

ALUM injection, 10 gr. to the pint, after previous washing out in chronic catarrhal cases, 405.

AMMONIUM Chloride and sometimes acetate useful; also the Benzoate for phosphatic deposits, 397.

BORAX and BORIC Acid in injection, also by the mouth, 300.

BALSAMS. BELLADONNA.

BROMIDES in acute cases with urethritis, 149. BUCHU.

CANTHARIS. CARBOLIC Acid.

CARBONIC Acid gas injected per catheter, 305.

HYDRASTIS. IODOFORM in suppository relieves pain.

IRON as general tonic, also as astringent injection for hæmorrhage, 636.

LIME salts for effects of uratic calculi, 586; lime water by injection.

LINSEED. MALT injection suggested to induce lactic acid fermentation.

MINERAL waters—Alkaline, 229, Compound Soda, 237, Earthy, 288 (Wildungen, Contrexéville).

NITRIC, 339, or HYDROCHLORIC Acid, 320, in full doses for phosphatic cases; also by injection.

OPIUM. PAREIRA. PHENAZONE for pain, etc., and 4 oz. of 1 per cent. solution for injection.

PHOSPHORIC Acid, in full doses for phosphatic cases, also by injection; has relieved after failure of other acids, 354.

POTASH Salts, for effects of uric acid calculi, 802.

PYOCTANIN or RESORCIN injections.

RHUS. SALICYLATES. SANTALWOOD Oil. SAW PALMETTO.

SILVER Nitrate, 1-2 gr. to the ounce as astringent injection. 453.

SULPHITES as urinary disinfectants.

TRITICUM, fl. extr. (B.P.C.), dose, 1 to 4 dr. UROTROPIN. UVA URSI.

ZEA MAYS (corn silk), fl. extr. (U.S.P.), dose, 1 to 4 dr.

v. Calculi.

CYSTS, ovarian, abdominal.

BROMIDES, for absorptive effects, 155.

IODINE tincture injected, 92-3.

Surgical.

DANDRIF.

v. Seborrhœa.

DEBILITY.

ACIDS, especially Nitric, 339, and Phosphoric, 353.

ALCOHOL. AMMONIA in combination with Bitters, etc., 391.

ARSENIC for anæmic cases with neuralgia, 508-9.

CASCARILLA, CINCHONA, and other Bitters. COCA. COD OIL. Galvanism, 185-8. Massage.

IRON, generally in combination with the above, if digestion permit, 651.

LIME Phosphate for anæmic and strumous cases, 583. MALTINE.

NUX and its alkaloids.

PHOSPHORUS and hypophosphites in nerve cases, 59. QUININE.

SILVER Nitrate for nerve debility, etc., 463.

Water in douche, etc., 171-2.

Sea bathing, 213.

ZINC Phosphide or Valerianate when anæmia is not marked, 854.

DELIRIUM.

ANTIMONY, in fever, 427.

BROMIDES (in combination), 151.

v. Alcoholism, Fever.

DENTITION.

BROMIDES as sedative, anti-convulsive, 123. Baths, warm. Gum lancet.

CALOMEL, small doses often suitable.

LIME salts in rachitic cases, 581.

DEPRESSION, mental. DEMENTIA.

Feeding, rectal or by stomach tube if necessary. Massage. Electricity.

PHOSPHORUS, 62; other tonics and stimulants. Moral treatment.

v. Debility.

DERMATITIS, traumatic.

Soothing remedies as under Eczema.

DERMATITIS herpetiformis.

v. Hydroa.

DERMATITIS exfoliativa.

v. Pityriasis rubra.

DIABETES insipidus.

ALUM, 407. AMYLENE HYDRATE (m xv) relieves thirst, etc.

BROMIDES, generally with Cannabis, Belladonna, etc. ERGOT.

Galvanism, central.

IRON, QUININE, and general tonics, including COD OIL.

JABORANDI. PHENAZONE, TRINITRIN.

VALERIAN in full doses, or the Valeriate of Zinc.

DIABETES mellitus.

ALKALIES relieve many symptoms, and aid oxidation, but require caution, 831; large doses given hourly, freely diluted, in *coma*, 810.

AMMONIUM Chloride, increasing metabolism, lessens sugar excretion, 396.

ARSENIC improves nutrition, 509.

BELLADONNA, good with OPIUM, often with BROMIDES, 149.

BENZOSOL (Guaiacol). COCAINE.

Diet. High-frequency currents.

ODOFORM, but value not proved, 120.

IRON, especially as bromide, or in Carbonated waters, 656.

LACTIC Acid. LÆVULOSE (invert sugar) as sweetening agent.

LIME Salts, carbonate, phosphate, sulphide (powdered eggshell used at Neuenahr).

LITHIUM Carbonate with Sodium Arseniate (Martineau).

MALT DIASTASE ferment lessens sugar (Lépine).

Mineral waters—Carlsbad, 237, Neuenahr, 232, Vichy, 229, etc.

OPIUM and its alkaloids.

OXYGEN, 15. PEROXIDE, 24. Pancreas (not dependable). PEPSIN.

PHENACETIN. PHENAZONE, perhaps the best after Opium.

PHOSPHORIC Acid relieves, 354.

POTASH Permanganate (Lépine) as oxidising agent and for thirst, 810.

SALICIN. SALICYLATES. SALOL.

SALINE injection, rectal or intravenous for *coma* or collapse.

SODIUM Citrate, sulphocarbolate, arseniate, 831.

URANIUM Nitrate valued by some, but not dependable, 842.

DIARRHŒA.

ACID, Hydrochloric, sometimes borne better than others, 319.

ACID, Nitric, in serous forms without inflammation or much pain, but Opium often combined, 339.

ACID, Sulphurous, more markedly antiseptic, in choleraic cases, 377.

ACID, Sulphuric, especially the aromatic, with Opium; or if the tongue is coated, with Magnes. Sulph. and Rhubarb, 361.

ALKALIES, preferable when there is hyperacidity; good with aromatics or in effervescence with Opium, 829.

ALOES, compound decoction, in occasional dose for chronic cases with watery stools.

ARSENIC in small doses, sometimes excellent in lenteric, dysenteric, and choleraic cases, and when diarrhœa follows food, 528.

BISMUTH compounds in irritative cases with red tongue, pain, etc., and in phthisis; sometimes with grey or Dover's powder, or compound Camphor tincture. The antiseptic compounds Orphol (β naphthol) or Carbolate, in 10 to 20 gr. doses. Salicylate in 3 to 10 gr. doses in fermentative forms, 556.

BROMIDES in reflex cases, *e.g.* during dentition, or from emotional causes, 148.

CAMPHOR. CARBOLIC Acid.

CASTOR Oil as eliminant, or in 1-4 m doses, with Morphia.

CHARCOAL. CHLOROFORM. CINNAMON. COTO tinct. 10 m doses for phthical and choleraic cases, not inflammatory or hæmorrhagic.

COPPER Sulphate in chronic and some infantile cases, 604.

CREASOTE, m $\frac{1}{2}$ -1, good with Bismuth. Diet, milk prepared or diluted, but omitted for a time if curds are passed; whey, albumen water, arrowroot water, raw meat or meat juice.

Enemata, antiseptic (Boric acid, etc.), for lavage of large intestine, or 1-2 oz. of warm starch emulsion with laudanum or astringents.

EUCALYPTUS gum and preparations.

GALLIC Acid. HÆMATOXYLON.

IODINE tincture in atonic and tubercular cases, 111.

IPECACUANHA in summer and dysenteric diarrhœa of children; small doses hourly.

DIARRHŒA (*continued*).

IRON, the wine in simple cases; the perntrate in chronic mucous, dysenteric, and tuberculous forms; sometimes the perchloride with Morphine, 657. KINO.

LEAD Acetate in obstinate and choleraic cases, generally with Opium, given also in suppository or injection, 782.

LIME Water and carbonate for children with acidity, and chronic cases; also the phosphate, 579.

MAGNESIA and Carbonate, first in purgative dose for irritative diarrhœa from unwholesome food, afterwards in small doses for acidity, often with Bismuth and ginger; the sulphate in $\frac{1}{2}$ -1 dr. doses several times, in similar and dysenteric cases, 749.

MERCURY.—Calomel, with Opium, followed by Castor-oil: for acute cases, grey powder with or without Bismuth, or minute doses of Perchloride for light or green watery offensive stools, 721.

OPIUM (in combination).

PEPSIN and peptonised foods, especially for children.

PODOPHYLLIN, small doses in hepatic cases with pale offensive stools.

Purgatives may be needed at commencement of treatment.

RHUBARB, as eliminant, or in small astringent doses with Soda and cinnamon, or Magnesia and ginger.

SALICYLIC Acid. SALOL.

SILVER Nitrate and Oxide in serous and dysenteric, also in chronic periodic forms, 465.

TANNIC Acid. TANNALBIN (albuminate) for infants 2-5 gr., adults up to 30 gr.; is tasteless and insoluble in the stomach. TANNIGEN (triacetyl Tannin), do., do., 15-20 gr. for adults, good with Salol. NAPHTHALIN, $\frac{1}{2}$ -2 gr. for children.

Water in various forms—bath, pack, compress, douche, poultice, etc.

ZINC Oxide in infantile, the Sulphate in chronic cases, 852.

DIPHTHERIA.

ANTITOXIN, average initial dose 2000 units, which may be followed by one or more doses of 5 to 600 units: if treatment delayed for some days, 4000 or more for a 5-year child; repeat in 12 hours.

BORIC Acid in strong solution or spray, frequently applied; also BORAX, but not so effective, 299.

BROMINE by inhalation and internally, 125; also Bromides.

CARBOLIC Acid, 3 p. c. alcoholic solution as paint, half strength as spray.

CHLORINE solution and chlorinated Soda, as gargle and spray, 160.

CHLORAL Hydrate, 1 in 8 of glycerin as paint.

CHROMIC Acid solution, 40 per cent., lightly applied to false membranes, 309.

COPPER Sulphate as emetic, and locally in solution, 605.

Food important, may be peptonised.

HYDROGEN Peroxide, not less than 3 per cent. (10 vols.), internally, and applied as paint, spray, or gargle, 24.

IODINE in spray or inhalation, 87; and Iodides internally, 107.

IRON Perchloride or sulphate, locally or internally, very good, 639.

Intubation or Tracheotomy.

Irrigation, antiseptic, of nasal passages in later stages.

LACTIC Acid, with 1 to 3 parts of water as paint, or 1 in 8 of LIME Water in warm spray, or by laryngeal brush, or as saccharate.

LITHIA Carbonate as vaporised solution to dissolve membrane, 738.

MENTHOL paint or Peppermint oil in full strength, locally.

MERCURY, as iodide, cyanide or perchloride, 709; the last also locally, 1 per cent. solution in alcohol, cautiously, 3-4 times in 24 hours.

PAPAIN powder, solvent of membrane.

POTASH Salts, especially chlorate with iodide; also permanganate, 805; and, less often, the bichromate.

RESORCIN, locally, in 1-2 per cent. solution. SALICYLATES, do., also internally.

SILVER Nitrate, sometimes by insufflation or weak spray, 457.

Stimulants generally after the first few days.

SULPHUR, sulphides, sulphites, sulphurous acid, locally, internally, 40, 363-9. TURPENTINE vapour.

Water in compress, as ice, or as steam which may be medicated.
v. Debility, Paralysis, Nephritis.

DIPSOMANIA.

v. Alcoholism.

DIVERS' PARALYSIS (Caisson Disease).

The best treatment is said to be putting the patient in a compressed atmosphere again.

ERGOT. OPIUM for pain. OXYGEN, 16.

DROPSY.

v. Ascites, Anasarca, Albuminuria.

DYSENTERY.

ALUM in later stages, internally or as rectal injection, 408.

ARSENIC best in malarial cases, 528.

BAEL fruit, extr. liq. \mathfrak{z} i- \mathfrak{z} ii doses.

BISMUTH Salts in large doses by the mouth or by enema, 557.

CASTOR Oil as eliminant early, or 2-3 m doses with Morphia and mucilage, after motions.

CREOLIN, internally (3 m) or as rectal injection ($\frac{1}{2}$ per cent.); also Izal (5 per cent.).

ENEMATA of starch and Opium, or of ice water; antiseptic or astringent irrigation of rectum and colon, as by weak Sublimate or Silver nitrate solution, 465.

HAMAMELIS for hæmorrhage.

IPECACUANHA, in acute forms, 30 gr. of powder every 8 hours, or 60 gr. as a first dose to produce vomiting, and followed by hourly doses of 3 gr. until normal motions, or 10 gr. at first, in chronic cases.

LEAD Acetate, good with Camphor and Opium in later stages, 782.

MAGNESIUM Sulphate in \mathfrak{z} ss to \mathfrak{z} i doses, 749, or Sodium sulphate \mathfrak{z} i doses every 3-4 hours, 833.

MERCURY Perchloride as injection, 1 in 5000, or internally $\frac{1}{100}$ gr. every hour, 721; or Calomel in small doses hourly in acute cases, unless markedly asthenic.

Milk diet in chronic cases (Psilosis). OPIUM and its alkaloids, but better avoided in acute stages.

QUININE in malarial cases, also *per rectum* for amœba coli. SALOL.

SILVER Nitrate, internally, or in copious enemata, 10 gr. to the pint, followed by Sodium chloride injection if necessary, 465.

TANNALBIN, 10 to 15 gr. doses. THYMOL, $\frac{1}{2}$ to 2 gr. in pill.

TURPENTINE for prostration and hæmorrhage.

cf. Diarrhœa, Psilosis.

DYSMENORRHEA.

ACONITE for acute congestive cases, in small frequent dose.

Alcohol (with caution).

Aperients before the period.

APIOL, 3 m in capsule, also as "Menthol Petroselin" in dragées.

BELLADONNA internally, or suppositories of the extract.

BROMIDES specially useful in congestive and neurotic cases, 145.

CAMPHOR. CANNABIS Indica acts best in menorrhagic cases.

CASTOREUM tincture, 20 m doses.

CAULOPHYLLUM (Cohosh) tinct., or Caulophyllin pulv., gr. 1 to 4 (anti-spasmodic).

CHLORAL. CHLOROFORM. CIMICIFUGA relieves headache and pain, best in rheumatic subjects.

Dilatation or other surgical procedures. Electricity.

GELSEMIUM in neuralgic spasmodic cases. GLYCERIN tampons.

Heat and hot baths, sometimes douches (vaginal).

IODIDES and other anti-rheumatic remedies, 110.

Leeches. AMYL NITRITE, 3 drops to be inhaled, or taken on sugar.

OPIUM and alkaloids (with caution).

Pessary for displacements.

PHENACETIN. PHENAZONE and congeners. PULSATILLA tinct. 5-15 m.

VALERIANATES. VIBURNUM prunif. (black Haw), Ext. liq., 1 dr. doses.

v. Endometritis, Neuralgia.

DYSpareunia.

BROMIDES as lessening sensibility and reflex, 148.

IODOFORM in powder or tampon produces local anæsthesia, 118.

Surgical, *e.g.* for urethral caruncle.

DYSPEPSIA.

ACIDS, Hydrochloric, 317, Nitrohydrochloric, 343, or Nitric, 339, generally the first, in atonic cases best shortly after food; sometimes indicated in cases of acidity, and then better half an hour before.

DYSPEPSIA (*continued*).

ACID, Hydrocyanic dilute, generally in combination, for pain, pyrosis, or palpitation; also Cherry laurel water, 3ss to ʒij doses, 332.

ALKALIES, generally Soda, 828, in atonic cases small doses before food, generally with a bitter; in cases with acidity, larger doses an hour after; POTASH indicated in rheumatic and gouty subjects, 801.

AMMONIA, the carbonate indicated for flatulence and acidity, often with Soda and a bitter; the Chloride with acid, when bile deficient, 395.

ARSENIC, sometimes in neuralgic or irritative dyspepsia with tendency to diarrhœa,—drop doses before meals, 527.

BISMUTH, when pain and pyrosis without undue constipation, 554.

BITTERS—Calumba, Gentian, Quassia—Nux vomica and alkaloids, etc., in atonic cases.

BROMIDES, that of Strontium best, for gastralgia and flatulent dyspepsia, 148.

CHARCOAL for the special symptoms of distension and flatulence, 28.

CARBONIC Acid gas dissolved in water (generally alkaline), as gastric sedative, 306.

CERIUM Oxalate for sickness and nervous dyspepsia, 583.

Compresses or warm applications to the epigastrium, with compression of abdomen, 177. Diet.

Emetics in acute cases due to irritants. Lavage in dilatation, etc.

GOLD Chloride for nervous dyspepsia and duodenal catarrh (not in the plethoric), 538.

IODOFORM has been given to prevent fermentative changes, 119.

IRON Salts in some forms of atonic dyspepsia with anæmia, 656.

LIME Water, carbonate and saccharate in acidity with nausea, and in chlorotic cases,—often more effective than alkalies, 578.

MAGNESIA used similarly, often with Bismuth and carminatives, if headache, colic or constipation, 747.

MALT Extract as digestive.

MANGANESE Oxide for gastrodynia and pyrosis, 761.

Massage. Electricity.

MERCURIAL compounds as cholagogue purgatives, 720.

Mineral Waters, especially the "Indifferent," the Muriated, and Compound Soda, 219-20.

MORPHIA, small doses with alkalies, and PAPAIN in irritative cases.

PEPSIN. PANCREATIN.

PEROXIDE of HYDROGEN has been given in chronic cases, 23.

PHENAZONE for neuralgic pain.

RESORCIN, 3 to 5 gr., anti-fermentative and pain-relieving.

SILVER Oxide and Nitrate in chronic catarrhal and nerve cases, especially when menorrhagic, 462.

SULPHITES and Sulphocarbulates for fermentation, distension and flatulence, 5 to 10 gr. doses or upwards, *cf.* 378.

Sea-bathing and other forms of bath for general tonic effects, 174, 213.

Water drinking, systematic, an hour or so before meals, 211.

ZINC Oxide, like Bismuth, for dyspeptic pain with looseness of bowels; the Sulphate has benefited oxaluric cases, 852.

For special symptoms, *cf.* Acidity, Constipation, Flatulence, Gastralgia, etc.

DYSPHAGIA.

BROMIDES, when reflex as in children, and also when from local irritation, as in phthisis, 147.

Surgical.

DYSPNŒA.

Cardiac—OXYGEN, 14. NITRITES.

v. Angina pectoris.

Pulmonary—*v.* Congestion, Asthma,

Pleurisy, Pneumonia, etc.

Toxic—*v.* Diabetes, Uræmia, etc.

DYSURIA.

Alkalies, acids, or antiseptics according to cause.

Anodynes. Surgical.

v. Cystitis, Gonorrhœa, Prostatitis.

EAR-ACHE. *v.* Neuralgia, Otorrhœa.

ECLAMPSIA. *v.* Convulsion.

ECTHYMA. *v.* Eczema.

ECTROPION—ENTROPION.

v. Blepharitis.

ECZEMA.

ALUM lotion in chronic cases, Acetate and Alumol in subacute, 402.

ANTIMONY in acute cases of full habit; well combined with saline aperients, 429.

ARSENIC best in chronic scaly conditions in weakly subjects, 520.

Baths, medicated, emollient, alkaline, sulphurated, tar, for chronic cases, 216; prolonged tepid as at Leuk, Schinznach, Uriage, etc., 281-8.

BISMUTH compounds in lotion, ointment or oleate as absorbent, soothing and slightly astringent, for subacute cases, 552.

BORIC Acid ointment or glycerin for subacute dry irritable forms; also as antiseptic addition to other lotions—10 gr to the oz., 299.

BORAX used similarly and for cleansing purposes with oatmeal or mucilage, 826.

BROMIDES, alkaline, with simple ointment or glycerin, 1 to 5, for chronic cases, 137; internally as sedative.

CAMPHOR added to dusting powder (2 per cent.) to lessen burning, etc.

CANNABIS Indica internally, relieves itching. CARBOLIC Acid lotion, oil or ointment. COCAINE as local sedative.

COD-LIVER Oil in subacute and chronic cases.

Counter-irritation over neighbouring nerve-centres. Electricity.

GELSEMIUM internally, lessens congestion and irritation.

ICHTHYOL, or better THIOI, 10 to 20 per cent., generally in a paste with Zinc oxide, starch and vaseline for subacute cases.

IODINE tincture sometimes good in chronic congestive states, but may irritate, 96; Iodides internally in chronic infiltrated forms.

IODOFORM and its congeners, ARISTOL, etc., in ointment, especially for chronic eczema capitis (lessening pus formation), 116.

IRON Perchloride with glycerin locally in chronic infiltrated cases, 636, the Sulphate internally with

Magnesian or Soda sulphate for cases with debility and constipation, or as Blaud's pill.

LEAD Acetate in water or milk, Carbonate with oil or glycerin as soothing astringent, also in ointment or plaster mixed with oil, 779.

LIME Phosphate in some chronic conditions with impaired nutrition, Chalk ointment locally, often with Tar, 576. Linim. Calcis for more acute stages.

LIQ. PICIS Carbonis, often good, but not for acute conditions.

MAGNESIAN Sulphate and carbonate, often with Colchicum, for inflamed and especially gouty conditions.

MERCURIAL compounds in alterative doses for chronic cases, also locally as lotion, oleate or ointment, often combined with Tar compounds, or with equal parts of the Lead and Zinc ointments, 694.

Mineral waters, Saline and Sulphurous, for gouty cases, specially Royat and La Bourboule, 271.

PHENAZONE for painful, inflamed, pyrexial conditions.

PICRIC Acid saturated solution to inflamed weeping surfaces (with caution as to kidney condition).

PILOCARPIN for markedly dry skin.

POTASH Bicarbonate in weak lotion for early stages; the hydrate for chronic infiltrated patches; internally with the acetate and nitrate, or in effervescence, 799-803.

PRUSSIC Acid and cyanides in lotion or ointment as sedative in the erythematous stage; use cautiously if skin broken, *cf.* 332.

RESORCIN, 2 to 5 per cent., with spirit and glycerin, especially for seborrhœic cases, subacute.

Rubber bandages for varicose eczema.

SALICYLIC Acid ointment or paste, with Zinc oxide, vaseline, and starch (Lassar), or in plaster, 2 to 5 per cent.

SILVER Nitrate, sometimes in pudendal cases in lotion, 2 to 4 gr. in the oz., to relieve itching, etc., or for chronic patches, 30 to 40 gr. in the oz. of nitrous ether, 460.

SOAPS, medicated, sulphur, menthol, superfatted, etc., or in tincture, *e.g.* soft soap, 65; oil of lavender, 2; alcohol to 100 parts (U.S.P.) for chronic patches.

ECZEMA (*continued*).

SODIUM Carbonate or Borate, in lotion, 20 to 60 gr. in 8 oz. of diluent, or in 1 oz. of Zinc ointment for early inflammatory stages, 826.

Starch poultice for acute stages, preferably with Boric acid, 1 dr. to 1 pt.

STRYCHNIA as nerve tonic.

SULPHUR, in bath or ointment, for later stages and chronic patches, especially seborrhœic, 36. Sulphides internally, 38.

TANNIN, also for seborrhœic cases.

TAR preparations in chronic cases, especially anal.

VIOLA Tricolor (pansy), fl. extract, U.S.P., locally in ointment and internally, mostly for children.

ZINC Oxide or Carbonate in lotion, ointment, or paste, for acute and subacute cases, or the Sulphate as a stimulating astringent, 850.
v. Erythema, Pruritus, etc.

EMBOLISM.

AMMONIA, full doses hourly (in other than cerebral cases, 391).

SODIUM Carbonate (alkali) said to favour collateral circulation, 833.

EMPHYSEMA.

Air, compressed, 11.

ARSENIC, in chronic bronchitic cases, internally and in cigarette, 513.

ANTIMONY, especially in combination with last as Arseniate, 439.

CAFFEINE, DIGITALIS, STRYCHNINE, and other cardiac tonics often benefit. COD-LIVER Oil.

HYDRIODIC Acid and Iodides, 106.

IPECACUANHA; spray good for bronchial catarrh and winter cough.

IRON Perchloride and Phosphate improve general health and capillary circulation, 654.

OXYGEN gives much temporary relief to the dyspnoea, 10.

NITRITES deserve trial when spasm present; nitrous fumes for bronchial complications, 837.

TURPENTINE and other liniments to the chest. v. Bronchitis.

EMPYEMA.

Aspiration or incision, with partial resection of rib.

Antiseptic injections if necessary.

OXYGEN sometimes useful, 11.
v. Abscess.

ENDOCARDITIS.

Rest. Blister. Poultice. Compress.

ACONITE, cautiously. ALKALIES, 803.

IODIDES. HYDRIODIC Acid, 100, 804.

MERCURIALS, but not so depended on as formerly, 707. OPIUM.

SALICIN or SALICYLIC compounds.

cf. Pericarditis, Rheumatism.

ENDOMETRITIS.

ANODYNES, anodyne liniments, or plasters for referred pains.

CARBOLIC Acid, CHROMIC Acid, locally, 309. Curetting or other surgical treatment if required.

ERGOT useful when convalescent.

Hot water douche, with disinfectants in septic cases. Hot fomentations or poultices for pain.

IODINE and Iodides, locally, 88, and internally, 110.

Leeches round anus in severe cases.

MORPHIA useful in suppository.

NITRIC Acid for local application, with precautions, 337.

SILVER Nitrate, etc., do., do. 441-55.

ENTERITIS, acute.

Aperient may be required, Calomel, Oil, or enemata.

BISMUTH compounds, 556, often with sedatives, *e.g.* Dover's powder.

Diet, bland and possibly stimulants, not fat or much farinaceous food.

MERCURIALS, especially Perchloride, in small doses, *cf.* 721.

MAGNESIAN Sulphate for a few doses as eliminant, 749.

v. Diarrhœa, Dysentery.

ENTERITIS, chronic, generally ulcerative.

ANTISEPTICS and treatment as above, if diarrhœa present.

Enemata for constipation.

v. Colitis.

ENURESIS.

ALKALIES, if urine acid enough to cause irritation, 802. Aperients or Anthelmintics as required. Lessen fluids in diet, and use local bathing.

BELLADONNA in full doses.

BROMIDES lessen reflex spasm in simple cases, 147.

CANTHARIDES tincture, 1 to 2 m doses. ERGOT may be given with the preceding.

ENURESIS (*continued*).

Electricity to urethra and sacrum, or epigastrium.

IRON Bromide, iodide, phosphate or perchloride in scrofulous children, with irritable mucous membranes or worms, 635.

LYCOPodium tincture, 15 to 60 m doses. RHUS aromatica, tincture, 5 to 10 m for children, thrice daily.

SILVER Nitrate to urethra; strong, or weaker in injection.

STRYCHNINE, often with Belladonna. Surgical if from stone, prostate, etc.

EPHELIDES (Freckles).

BORAX (with benzoïn) lotion sometimes used, *cf.* 826.

Electrolysis, mild and brief to spots. HYDROGEN Peroxide, 2 p. c. lotion, *cf.* 23.

IODINE, decolorised and diluted.

LACTIC Acid 1 in 10 or 20.

MERCURY Perchloride either in strong solution to cause peeling, or weaker— $1\frac{1}{2}$ gr. to the oz.—with Lead and Zinc salts, or Tr. Benzoin, 695; or the Ammoniated ointment with Bismuth.

Salicylic Acid, 10 to 25 per cent., acts by causing peeling.

EPIDIDYMITIS.

v. Orchitis.

EPILEPSY.

ARSENIC suitable for some cases, especially in combination with Bromine, 516.

BARIUM, formerly given and lessens reflex excitability, 544.

BELLADONNA, in minor nocturnal forms.

BORAX of value in some chronic cases, especially those with amenorrhœa, 834.

BROMIDES, especially in sthenic, congestive and traumatic cases, preferably combined, 137.

BROMIPIN, 33.3 per cent. (3i = 10 gr. of Bromide) in capsules, 141.

CEREBRIN, 15 gr. daily or by the skin; sedative, not depressant, (*cf.* Therapist, April, 1903).

CHLOROFORM for convulsions.

Compression of carotids has shortened or prevented an attack.

Counter-irritation, such as blister to seat of aura, or seton in nape.

COPPER Ammonio-sulphate in hysterical cases, or when dependent on worms, 603.

DIGITALIS. Galvanism, central.

GOLD Chloride or Bromide advised, even if organic brain lesion, 538.

HYDROBROMIC Acid, like bromides, less depressing, less effective, 311.

HYOSCINE Hydrobromide, $\frac{1}{200}$ th to $\frac{1}{100}$ th gr.

IODINE or Iodides (syph. and rheum. cases), with Bromides, 99.

IRON in the anæmic and hysterical, with Bromides, 143.

MERCURY if syphilis has preceded.

PHENAZONE with Bromides.

PHOSPHORUS relieves depression and improves nerve power, 61.

PICROTOXIN especially for nocturnal.

NITRITES of Amyl, Ethyl, Glycerin or Sodium, relieve some patients better than bromides, 837.

SILVER Nitrate or chloride, acts best in the delicate and anæmic, 466.

SODIUM Chloride, 3i to 3ij doses (Nothnagel).

STRYCHNINE, for nocturnal cases chiefly.

ZINC Oxide or lactate in some cases probably congestive; also the Bromide in hystero-epilepsy, but not well borne, 853.

EPISTAXIS.

ALUM applied solid, powdered or in solution, or with Benzoin and alcohol, 406.

CALCIUM Chloride, 20 gr. doses, 585.

HYDRASTIS, HAMAMELIS, locally and internally.

IRON Acetate, sulphate or perchloride especially in the anæmic, 628.

Lemon juice, fresh, a good injection. Position semi-recumbent with arms raised; local pressure and cold; a foot-bath hot.

SALT in drachm doses sometimes effective, 833.

Surgical. Plugging nares with puff-ball, etc.

SUPRARENAL Gland tablets dissolved, or ADRENALIN solution m 5 to 10 in repeated doses, and locally applied.

TANNIN. TURPENTINE.

Water, hot or cold locally or to the nape; warm to the extremities.

EPITHELIOMA.

v. Cancer.

ERYSIPELAS.

ACONITE at commencement.

Anti-streptococcus serum, 10 to 20 cc.

AMMONIUM Acetate or Citrate for pyrexia, Carbonate for exhaustion.

ANTIMONY in small frequent doses, but other remedies better, 428.

ARSENIC in late stages if sloughing threatened, 525.

BELLADONNA extract locally, tincture internally.

BISMUTH Salts in dusting powder, cream or ointment, 552.

BORACIC Acid and starch powder for simple cases.

BROMINE, as caustic, with precautions, 124, a doubtful remedy.

CALCIUM Chloride in weak lotion, Carbonate as dusting powder, 576.

CAMPHOR. CARBOLISED Oil, 1 in 8, or Carbolic acid with chalk ointment (6 per cent.), or injected (2 to 4 per cent.).

ICHTHYOL and Lanolin, equal parts, cover with antiseptic cotton wool.

IODINE tincture locally, to control inflammation, 95.

IODOFORM Collodion, 119; or 4 parts to 1 of Creolin, and 10 of Lanolin as ointment (Koch).

IRON Sulphate or perchloride, locally and internally, in full doses, 637.

LEAD lotion with Opium—the Carbonate with oil or cerate, 778.

MAGNESIA or Carbonate locally, 746; Sulphate as aperient.

MERCURY, in ointment or plaster; Perchloride in spray, internally in phlegmonous cases, 697-713.

PICRIC Acid, 2 per cent., or saturated solution.

PILOCARPINE. QUININE (or Bark). SALICYLATES.

SILVER Nitrate, strong solution sometimes effective in superficial forms, 459.

Stimulants in severe cases.

STYCHNINE by the skin may be required for exhaustion.

SULPHUROUS Acid and Sulphites in spray or lotion and internally, 367; sulphocarbolsates.

TURPENTINE as paint and internally.

ZINC Oxide or Carbonate in powder or lotion, 851.

Water, in pack or warm bath gradually cooled.

ERYTHEMA, simplex, multiforme, nodosum.

Dusting powders or lotions of Bismuth, Chalk, Ichthyol, Lead, Magnesia, Zinc, etc.

Internally Bismuth, Rhubarb, Magnesia, or other remedies for dyspepsia, for constipation, rheumatism, uterine disorder or other possible causes. ADRENALIN.

CALCIUM Chloride for exudative cases. IRON and tonics for anæmia and debility. v. Pruritus.

EXOPHTHALMOS.

ARSENIC sometimes, as hæmatic and nerve tonic.

BARIUM Chloride, $\frac{1}{16}$ th to $\frac{1}{10}$ th gr. (in pill), lessens palpitation, 543.

BELLADONNA, a good adjuvant.

BROMIDES, often in combination, 149.

DIGITALIS. ERGOTIN.

Galvanism of sympathetic.

IODIDES, IODINE tincture, lessen palpitation, 109.

IRON sometimes useful, but apt to cause headache.

SODIUM Phosphate, also Salicylate.

STROPHANTHUS very serviceable.

THYMUS or THYROID substance, cautiously. Surgical.

FAVUS.

v. Tinea favosa.

FEBRICULA—FEVER.

As a symptom *per se* requires little medicinal treatment, but sometimes sponging, aconite, salines, or diaphoretics.

FEVER, malarial.

v. Ague.

FEVER, puerperal.

Antisepsis and cleanliness.

ACONITE. Alcohol. Aperient.

CALOMEL and inunction in early stages recommended by some, 712. Perchloride irrigation, 1 in 4000 (with care), 691.

CARBOLIC Acid or CREOLIN, by irrigation (2 per cent. hot), or in full strength as paint locally.

OPIUM or hypodermic Morphia.

POTASH Permanganate irrigations, 1 to 2 per cent.

QUININE, 10 gr. doses and upwards.

PHENAZONE. SALICYLATES.

Saline injection intravenous or other.

FEVER, puerperal (*continued*).

SILVER salts (Credé), Collargol ointment, 15 p. c. by inunction, *cf.* 459.

STRYCHNIA for collapse. SULPHITES, 375. TURPENTINE.

WARBURG's tincture, $\frac{1}{2}$ oz. dose for prostration with fever. Surgical.
v. Peritonitis, Pyæmia.

FEVER, RHEUMATIC.

v. Rheumatism, acute.

FEVER, TYPHOID, TYPHUS.

ACIDS, HYDROCHLORIC dilute, 319;
PHOSPHORIC when depression marked, 354; SULPHUROUS, very serviceable, 376.

AMMONIUM Salts, with organic acids, Acetate and Citrate; the Carbonate as stimulant, but not always advisable, 392.

ANTIMONY, formerly as emetic, or sedative with Opium, now, if at all, in small frequent dose at commencement, 427.

BETOL, 5 gr. doses, or other naphthols, if kidneys sound.

BISMUTH Salicylate for diarrhœa, 556.

CALOMEL, one or two full doses in early stages, sometimes small doses continued, 711.

CARBOLIC Acid, 1 to 2 gr. in pill.

CHARCOAL for tympanites, 29.

CHLORINE, with Quinine, 162.

COPPER Acetate or sulphate in small doses as astringent, 604.

Diet liquid, possibly stimulants.

EUCALYPTUS Oil and gum.

MERCURIAL Perchloride or per-iodide in small doses as antiseptic, 712; combined sometime with Tr. Ferri perchlor. (Wedgwood), or Guaiacol, etc. (Woodbridge); by some, inunction recommended.

OPIMUM. PHENACETIN and congeners.

QUININE. SALOL.

SILVER Nitrate with Belladonna and Opium, after second week, 466.

THYMOL. TURPENTINE as stimulant and styptic.

UROTROPINE, 4 to 8 gr. doses as antiseptic; omit if hæmorrhage. Water as drink and in cold affusion, spongings, packs, baths gradually cooled, or iced, 199; ice ca., 175.

For complications, see under Delirium, Diarrhœa, Headache, Hæmorrhage, Insomnia, etc.

FIBROMA, uterine.

BROMIDES as absorbents, sometimes successful, 154.

CALCIUM Chloride and Carbonate have lessened growth, 585.—

Ergot. HYDRASTIS.

IODINE or IODIDES generally combined with the preceding, 110.

IRON for anæmia, or with Ergot as astringent, locally as styptic, 631.

Mineral Waters—Kreuznach, 255; Woodhall, 263, etc.

Surgical, including electricity.

v. Menorrhagia.

FISSURE, anal.

Surgical.

BISMUTH in ointment, 553; with Belladonna, Cocaine or Conium.

BROMIDES, alkaline, with glycerin and simple ointment (1 to 5), 137.

CALOMEL ointment. CARBOLIC Acid as caustic. Galvanism, one electrode above sphincter, 5 minutes current (Donner).

ICHTHYOL suppositories (15 p. c.).

IODOFORM, *do.* (anæsthetic), 118.

IRON Persulphate, 10 gr. to the oz. of a sedative ointment.

LIQ. CALCIS Chlorinatæ, on wool inserted, relieves pain and itching (Berger), *cf.* 160.

SILVER Nitrate, caustic or stimulant (painful), *cf.* 455.

SULPHUR a suitable aperient, 42.

FISTULA.

Surgical (including galvano-cautery).

ACETIC Acid with Copper and Zinc sulphates, and Lead acetate injection, 602.

BENZOIN, compound tincture, *do.*

IODINE tinct., *do.*, after operation, 94.

CARBOLIC Acid, strong, on probe.

ZINC Chloride solution, *do.*

FLATULENCE.

AMMONIA as stimulant, generally with other alkali, 395.

ASAFCETIDA. BENZONAPHTHOL, 4-8 gr.

BETOL, 3 to 8 gr. doses, often with BISMUTH Salicylate, or Oxide,

which also may be given with CHARCOAL before meals, especially when pain and pyrosis, 28, 556.

CAJUPUT Oil, 3 to 5 m; Spirit, $\frac{1}{2}$ dr.

CARBOLIC Acid, 1 to 2 gr. pill.

FLATULENCE (*continued*).

CHLOROFORM. CLOVES. CREASOTE.
Diet dry, and lessening starch,
sugar, tea, etc.

GINGER and similar aromatics.

MERCURIAL and other purgatives as
required, 720.

NAPHTHALIN, 2 to 15 gr. doses in
cachet, pill, or malt extract.

NUX Vomica or its alkaloid.

PAPAIN. PEPPERMINT. PEPSIN.

RHUBARB. SALOL.

SODIUM Bicarbonate, sulphocarbon-
late, etc., in combination, 828.

SULPHUROUS Acid or sulphites, about
1 hour after food, *cf.* 378.

v. Dyspepsia.

FLUSHINGS (climacteric).

ADRENALIN, internally and locally,
or suprarenal tabloids dissolved.

BROMIDES as lessening vaso-motor
reflex, 148.

ERGOTIN. ICHTHYOL, locally and in-
ternally.

IRON for tonic effect, combined with
Bromide and saline. STRYCHNINE.

ZINC for nerve tone, especially as
Valerianate.

v. Dyspepsia.

FRACTURE or SOFTENING of Bone.

LIME Water, carbonate or phos-
phate, also organic and veget-
able compounds of these, assist
repair except in old persons, 580.

PHOSPHORUS and hypophosphites
stimulate bone-growth, 64-5.

FRECKLES.

v. Ephelides.

GALLSTONES.

Anæsthetics. Emetics.

Diet and exercise.

CALOMEL, full dose, followed by
Castor oil, *cf.* 720.

Electricity. Heat applied as fomen-
tation, bath, poultice, etc., also
hot drinks.

Mineral waters—Sulphated alka-
line (Carlsbad), 237; Alkaline
(Vichy), 229; sometimes Earthy
(Contrexéville), 290.

OLIVE Oil, 2 to 3 oz. or more, during
colic (15 oz. per rectum); also
daily during interval (or as oleate
of soda, or soap).

OPIUM or its constituents during
attack. PHENAZONE. EXALGIN.

SODIUM Carbonate, oleate (Eu-
natrol), phosphate, salicylate,
taurocholate, with copious water
drinking (hot), 830.

TURPENTINE, with Ether in cap-
sules. Surgical.

GANGRENE.

Surgical.

ACID Nitric, as caustic, 336.

ACID Sulphuric, has been used
mixed with inert powders, 361.

ARSENIC internally, serviceable, 526.

BROMINE, diluted 1 in 5, effective
but painful; may injure sense of
smell, 124.

CHARCOAL, cleansing and disin-
fectant in powder or poultice;
also in muslin bags near the
part, 28.

CHLORINE solution or chlorinated
Lime or Soda, as antiseptic, 160.

IRON Perchloride or persulphate,
locally applied; internally with
Quinine, 637.

OPIUM often very helpful for the
malady as well as for pain.

OXYGEN in jet to the affected part, 8.
POTASH Caustic, solid, and after-
wards in dilute solution, 797-9;
also chlorate and permanganate.

GANGRENE OF LUNG.

v. Bronchiectasis.

GAS POISONING.

Artificial respiration. OXYGEN, 9.
Transfusion of saline fluids.
Warmth.

GASTRALGIA—GASTRITIS.

ARSENIC useful in nerve cases, 510.

BISMUTH Salts, especially if pyrosis,
nausea, or looseness, 555.

CANNABIS Indica often relieves.

CERIUM and MANGANESE like Bis-
muth partly protective, 589, 761.

CHARCOAL, 29. CHLORAL. COCAINE.

Galvanism. Counter-irritation.

MORPHIA. MENTHOL. PAPAIN. PEP-
SIN. PHENAZONE.

PRUSSIC Acid relieves quickly suit-
able cases, especially of neuralgic
type with nausea, 332.

RESORCIN, 3 to 5 gr. doses, in fer-
mentative and ulcerative cases.

GASTRALGIA—GASTRITIS (*contd.*).

SILVER Oxide or Nitrate sometimes better than Bismuth in delicate neurotic subjects, 462.

SODIUM Salts, bicarbonate, 829.

ZINC Oxide like Bismuth, perhaps more tonic astringent, 852; Valerianate also good.

Water, hot, to drink, or foment; cold as compress.

v. Dyspepsia, Flatulence, etc.

GASTRIC AND GASTRO-DUODENAL CATARRH AND DILATATION.

Remedies as above; also CALOMEL, 3 to 5 gr. doses occasionally.

AMMONIUM Chloride has special action on gastric mucous membrane, lessening catarrh, 396.

Antiseptics—Benzonaphthol, Carbolic Acid, Sulphites, etc.

Diet important, lessen starch and bulky foods. Lavage.

POTASSIUM Iodide has special action on gastric mucous membrane, lessening catarrh; given with Soda salts (Ord). Bichromate, 808. Surgical.

GASTRIC ULCER.

ADRENALIN for hæmorrhage.

ALKALIES if acidity marked, generally in combination.

ARSENIC, small doses good in chronic forms, *cf.* 528.

BELLADONNA, Morphia and other anodynes as under Gastritis, generally by the skin or the bowel.

BISMUTH Salts relieve pain, but are apt to aggravate constipation, 555.

Counter-irritation (blister) over epigastrium. CREASOTE, chronic cases.

Diet limited to nutrients *per rectum* for 3 to 6 days in acute cases, ice perhaps being allowed for thirst; later, milk diluted or peptonised in small quantities every 2 hours, or raw meat juice, broth, jelly, prepared farinacea, etc.

Kino compound powder with opium, for pain and hæmorrhage.

Lavage for chronic, irritable cases, with Boric acid, Bismuth, Silver nitrate, 1 in 1,000 (Stewart), or Iron perchloride, 2 per cent.

Leeches sometimes indicated over seat of pain.

POTASH Iodide, with alkali in catarrhal cases; Bichromate, $\frac{1}{12}$ to $\frac{1}{4}$ gr., as antiseptic and stimulant to healing of ulcer, 808.

RESORCIN, *do.*, 3-5 gr. doses. SILVER Nitrate and Oxide, *do.*, $\frac{1}{4}$ - $\frac{1}{2}$ gr. doses, 465.

Saline aperients often desirable (Carlsbad salt). Surgical.

v. Collapse, Dyspepsia, Hæmatemesis, etc.

GINGIVITIS.

v. Stomatitis.

GLANDERS.

AMMONIA and other stimulants.

Tonics and concentrated foods.

Antitoxin (Mallein) *m*i, injected on alternate days.

Antiseptics—Sulphites, Sulphocarbonates, Carbolic vapour, etc.

Surgical, cautery, incisions.

GLANDS, Enlarged.

BARIUM Chloride, internally (Llan-gammarch waters), 543.

BROMIDES and IODIDES in strumous cases, 102-154; Iodine locally, 84.

CALCIUM Chloride, often serviceable; the Sulphide in small doses disperses or promotes healthier suppuration, 582.

COD-LIVER Oil and IRON, especially as Iodide, 660.

LEAD Acetate in lotion when in flamed, 778; in ointment of the Iodide as absorbent, 780.

MERCURY, in small doses of grey powder; locally as oleate, red Iodide, or other ointment, 698-717.

Mineral waters and baths, especially muriated and iodised—Kissingen, Kreuznach, Woodhall, 249-63, etc.

POTASH solution as absorbent; also the Chlorate, 807-8.

Sea-bathing and strong Salt solutions as resolvent, 213-832.

v. Lymphadenitis, Scrofula.

GLAUCOMA.

ESERINE. MORPHIA.

Leeches, fomentations. Surgical.

GLOSSITIS.

CHROMIC Acid, 10 gr. to the oz. of water, applied frequently, 308.

GLOSSITIS (*continued*).

GREY Powder in small doses, with
 Perchloride lotion in syphilis, 702.
 Hot fomentations containing Alum,
 Borax, Carbolic acid, Chlorate, etc.
 Leeches, punctures or incisions in
 urgent cases.
 Purgatives.

v. Salivation.

GOITRE.

v. Bronchocele—Exophthalmos.

GONORRHOEA—GLEET.

ALUM injections, 5 gr. to the oz.,
 or with Zinc sulphate, etc., in sub-
 acute or chronic cases, 405.
 ANTIMONIAL wine, 15 m (generally 2
 hourly), in acute cases, Sublimate
 injections being used, 429.
 BISMUTH Nitrate, 1 part to 8 of
 water, for soothing injection, 553.
 BORIC Acid, 10 gr. to the oz. of water,
 non-irritant antiseptic.
 BENZOIC Acid internally, a mild
 stimulant antiseptic to tract.
 BROMIDES locally and internally to
 lessen irritation and pain, 149.
 BUCHU, with Santal, etc.
 CARBOLIC Acid, 5-6 gr. to the oz.,
 CREOLIN, 6 per cent. for injection.
 CHLORINE solution, 1 in 12, or
 chlorinated Lime as injection, 160.
 CHROMIC Acid, 5 to 10 per cent. in
 water, do., 309.
 COPAIBA, with Potash, mucilage,
 etc., or in capsules for subacute
 or chronic stages.
 COPPER Sulphate, 1 to 2 gr. to the
 oz., with Lead acetate or alter-
 nately, 601.
 CUBEBS, powder in compound
 electuary, ʒij, with Nitre, ʒij,
 Santal oil, ʒiij, Dover's powder,
 ʒss, and Copaiba q.s. Dose ʒss
 to ʒi in wafer paper (not in acute
 stages).
 EUCALYPTUS. HYDRASTIS.
 IODINE tincture to affected part,
 especially in women, 89. IODO-
 FORM, 10 gr. to the oz., as bougie.
 IRON in chronic cases, sulphate or
 perchloride for injection and by
 the mouth, *cf.* 635.
 LEAD Acetate in gradually increas-
 ing strength from 2 gr. to the oz.;
 also with Zinc, 5 gr. of each to
 the oz. (Ricord), 780.

LIME Water as injection, generally
 as "black wash," 577.

MERCURIAL Perchloride, from $\frac{1}{2}$ gr.
 to the pint, or salicylate 4 gr., 701.

PEROXIDE, beginning with 4 per
 cent. solution, as injection, 24.

POTASH Salts, bicarbonate, acetate,
 nitrate, internally; Permanganate
 as weak injection, or better, irri-
 gation ($\frac{1}{2}$ gr. to the oz.), frequently
 in early stages, increasing gradu-
 ally to 1-5 gr. in later stages, 798.

SALOL. SANDALWOOD Oil, 20 m
 doses in capsule or emulsion,
 may begin earlier than Copaiba.

SILVER Nitrate, either as abortive,
 15 or more gr. to the oz., or in
 weak solution ($\frac{1}{2}$ gr. to the oz.) fre-
 quently, in early stages, stronger,
 later, 454; Protargol, or Argyrol,
 3-6 gr. to the oz., 441.

ZINC Sulphate, permanganate, sul-
 phocarbonate or chloride, in vari-
 ous strengths, 851.

For complications, *v.* Cystitis, En-
 dometritis, etc.

GOUT.

AMMONIUM Phosphate as preven-
 tive; also chloride and liquor, 396.

Anodyne liniments and ointments.

Aperients as required: Castor Oil or
 Saline, Rhubarb, Colocynth, etc.

CARBONIC Acid in strong alkaline
 draught, also in bath, 305.

COLCHICUM.

Electric baths, local and general.
 Counter-irritation to affected joints.

GUAIACUM, often with Sulphur, Rhu-
 barb, etc., in chronic cases.

HYDROCHLORIC Acid aids assimi-
 lation in some cases; acids usually
 not well borne, 321.

HYOSCINE as anodyne more suitable
 than Morphia.

IODINE and IODIDES in small doses
 well diluted (gouty subjects often
 intolerant), 101.

ODOFORM reported valuable, but
 not if kidneys unsound, 120.

LITHIA Carbonate, citrate or benzo-
 ate, best in subacute stages or
 intervals; also the quinate (Uro-
 sin) 8 gr., 4 to 6 times daily, 735.

MAGNESIA Carbonate with sulphate
 in chronic cases, often with Col-
 chicum, 752.

GOUT (*continued*).

Mineral waters and baths: Indifferent, 221,—Buxton, Bath, Wildbad; Muriated, 248,—Homburg, Wiesbaden, Baden-Baden, Salzschlirf, Salso-Maggiore: Alkaline, 229,—Vichy, Vals; Sulphated, 237,—Carlsbad; Sulphated-Muriated, 246—Leamington, etc.

HÆMOPTYSIS.

Counter-irritation. Cupping.

IRON Acetate or sulphate in anæmic subjects free from pyrexia, 628; in phthisis, insufflation of powdered sulphate or spray of perchloride.

v. Hæmorrhage.

HÆMORRHAGE.

ACETIC Acid dilute, locally, sometimes internally, 295.

ALUM applied locally, and given internally, best in passive cases, 5-10 gr. In hæmoptysis, combined with Sulphuric acid and Magnesian sulphate, also in hæmatemesis from cirrhosis, 406-7.

AMMONIUM Chloride in passive hæmorrhage and hæmaturia, 396. Bandage, Esmarch's probably best. Calcium Chloride, 10 to 20 gr. doses for a time only, 535.

COPPER Sulphate has been used for leech bites and epistaxis, 601.

CREASOTE. DIGITALIS.

ERGOTIN, 5 gr. by the skin, but increases blood pressure.

HAMAMELIS. HYDRASTIS. ICE.

IRON astringent compounds as local styptics, 627, and as above.

LEAD Acetate in various forms of hæmorrhage—pulmonary, intestinal and renal, 780; generally with Opium.

LYCOPERDON (puff ball). MATICO.

MAGNESIAN Sulphate often required with astringents (for tension), 751.

MANGANESE Chloride with Iron as local hæmostatic, but no special advantage, 757.

PHOSPHORIC Acid in purpura and passive cases, and hæmoptysis, 355.

POTASSIUM Nitrate, chlorate, tartrate and succinate in purpura and capillary hæmorrhage, in hæmoptysis (febrile), renal and rectal hæmorrhage (piles), 809.

SALT, drachm doses internally, or as "normal saline" by the veins for collapse; locally in solution, 833.

SILVER Nitrate for continued oozing from points in the skin or mucous membranes, 453.

STYPTIC Colloid (Tannin and Benzoïn). SULPHURIC Acid in passive cases, best combined with other astringents, 361. Surgical.

TURPENTINE, in vapour and by the mouth. Transfusion. TANNIN.

Water, hot and cold, locally, *e.g.*, in epistaxis or post partum, 189.

HÆMORRHOIDS.

ADRENALIN (or suprarenal extract dissolved), locally for strangulation or bleeding.

Aperients, mild.

ARSENIC relieves ordinary external and painful piles, probably by lessening venous congestion, 519.

BISMUTH, COCAINE, CONIUM, and other anodyne ointments and suppositories, *e.g.* of CALOMEL.

BROMIDE of Potassium with ointment or glycerin (1 part in 5), astringent, sedative, 137.

CARBOLIC Acid solution (1 in 10), 2 to 5 m injected into pile.

Cautery. Surgical.

GALL ointment with Belladonna.

HYDRASTIS, HAMAMELIS, locally and internally. ICHTHYOL, do.

IODINE tincture lightly painted on prolapsed inflamed piles, 95.

ODOFORM in ointment or suppository relieves pain of defæcation, 118.

IRON Perchloride and sulphate as hæmostatic rectal injection, or into the piles, or as ointment, 30 gr. to 1 oz.; also internally, 634.

LEAD lotion if painful and inflamed.

MERCURY as blue pill, calomel or grey powder, cholagogue aperients, 720.

NITRIC Acid in full strength to small granular piles; diluted, to swollen, bleeding surface, 337.

PEPPER, confection of, generally with Senna confection.

SULPHUR as laxative, also in small doses to improve venous and capillary circulation, 42.

TANNIN as ointment or injection.

Water, as drink and as douche, compress or fomentation, 192, 209. Mineral waters, Sulphated or Sulphated-Alkaline in stout persons, 237-44; Muriated in the thin and weakly, 248; Sulphuretted in either, 274.

HAIR falling.

v. Alopecia.

HAIR, superfluous.

BARIIUM Sulphide in paste, 1 with 4 of Zinc oxide as depilatory, 543.
Electrolysis.

HAY ASTHMA or HAY FEVER.

ACONITE.

ADRENALIN or Suprarenal extract, locally and internally.

AMMONIA vapour, carbolised.

ARISTOL insufflation, 121.

ARSENIC for nerve depression and paroxysmal sneezing, 526.

BISMUTH and Morphine snuff, 553.

BROMINE vapour from $\frac{1}{2}$ dr. in 4 oz. of alcohol, 125; bromides internally in some cases. CAMPHOR.CARBOLIC Glycerin 1 oz. with Quinine 1 dr. and Sublimate $\frac{1}{2}$ gr. (painful when first applied).

CHLORINATED Lime vapour or douche, 574.

CHLOROTONE, 15 per cent. spray with Paroleine, Menthol and Cinnamon oil;—antiseptic sedative.

COCAINE, 10 per cent. spray or $\frac{1}{6}$ gr. tabloids, relieves for a time, but may aggravate afterwards.

EUCALYPTOL vapour. HAZELINE locally.

Galvanic cautery in chronic cases.

IODINE vapour, carbolised or camphorated, 95; the Ammonium salt internally, 106.

IRON, QUININE, and other tonics.

MENT OL inhalation, or with Resorcin in alcohol as paint or spray.

MERCURIAL Iodide spray, 1 in 1000, has relieved after failure of others.

PHENAZONE, internally and in spray (15 gr. to the oz.).

SALICYLIC compounds.

SILVER Nitrate, 10 gr. to the oz., combined with antiseptic irrigation, or 2 to 5 gr. to the oz. for injection, 456.

SULPHUROUS Acid spray, etc., 369.

ZINC Valerianate has prevented recurrence, 855.

HEADACHE.

Air, fresh. Exercise. Aperients.

AMMONIUM Carbonate or acetate, in congestive or sick headache, good with effervescent alkali;

the chloride in nervous and men-strual cases, 395; also as lotion with Camphor.

BROMIDES in migraine; mixed bromides or Hydrobromic acid in congestive cases, 144.

CAFFEINE. CANNABIS. ERGOT.

Counter-irritation to nape. Electricity. Eyes, examination for astigmatism, etc.

GUARANA, especially in migraine.

HYDROCHLORIC, also NITRO-HYDROCHLORIC Acid, relieves the headache due to some forms of dyspepsia, 318-43.

IODIDES in obstinate cases (probably rheumatic or syphilitic); also in case of cerebral tumour.

IRON in anæmic cases non-congestive, generally combined with aperients, 646.

MAGNESIAN Salts, citrate and sulphate, or in mineral waters, as aperients, in congestive cases, 747.

MERCURY, blue-pill or calomel, as purge in bilious cases, 720.

PHENACETIN, PHENAZONE, and similar compounds for markedly neuralgic conditions.

PHOSPHORUS in cases of overwork, nerve-strain and depression, 59.

SILVER Nitrate in similar cases, also in the hysterical and hypochondriacal, 468.

SALICYLATES in uric acid cases.

SODIUM Bicarbonate (with Bitters) in dyspeptics, the phosphate in bilious subjects, 830.

STRYCHNIA, good combined with Ergot in persistent cases with debility.

Water, hot and cold, for bathing, affusion, compress or foot-bath.

ZINC, especially valerianate, in nerve cases, 855.

v. Dyspepsia, Dysmenorrhœa, Nephritis, etc.

HEART DISEASE (Chronic).

ADONIS, Adonidin (dose $\frac{1}{10}$ gr.) in fatty heart, and when Digitalis unsuitable; raises blood pressure.

Alcohol for syncopeal attacks, also Ammonia, Ether, etc.

APOCYNUM Cannabinum like Strophanthus, best in mitral or uræmic cases with dropsy, Tr. 5 to 60 m.

HEART DISEASE (*continued*).

ARSENIC in cardiac weakness with intermittent pulse, dyspnoea, etc., also in mitral disease and peripheral venous congestion, 517.

BARIIUM Chloride assists compensation and lessens pain, 543.

CONVALLARIA, Tr. 5 to 20 m for stenosis, heart failure, palpitation, etc.

DIGITALIS, heart tonic and diuretic. Dry diet (not more than 2 pints of fluid daily).

IODIDES in degenerative cases, and to lessen tension and promote elimination, 100.

IRON in degeneration, dilatation, mitral disease with dropsy, and whenever tension is lowered, 654; often with Digitalis or Strychnia, or both.

MERCURY, especially Calomel, as diuretic or purgative in the dropsy and congestions of mitral disease and dilatation (conjoined with saline aperients), 718.

Nauheim treatment (Saline gaseous baths, "resistant" exercises), improves capillary circulation and heart tone, 178-257.

OXYGEN for cyanosis and dyspnoea, 14. SALINE transfusion or injection for collapse. STROPHANTHUS. STRYCHNIA for weakness and dilatation (Easton's Syrup).

v. Angina Pectoris, Ascites, Endocarditis, Palpitation, etc.

HEMIPLEGIA.

v. Paralysis.

HEPATITIS, Hepatic disease.

Leeches sometimes required for relief of pain.

IODINE for external use, internally in later stages, 110.

MERCURIALS, 717. SODIUM Salts, 830. *v.* Congestion, Hepatic; Cirrhosis.

HERNIA.

Hot bath. Ice locally. Surgical.

HERPES, Labialis, Progenitalis.

Calamine or Lead lotions. Calomel as dusting powder. Boracic, or Zinc ointments or powders.

QUININE or other treatment of cause. *v.* Erythema.

HERPES ZOSTER (a neuritis).

ARSENIC in later stages, 525.

BELLADONNA or COCAINE, locally.

COLCHICUM relieves some cases markedly. COLLODION.

Counter-irritation in the course of affected nerve. Galvanism for relief of pain after the acute stage.

IRON Perchloride, internally for after-debility and pain (with Quinine), also with glycerin locally, or ointment of the sulphate, 636.

LEAD Lotion with Morphia for acute pain and inflammation, 778.

MORPHIA, PHENAZONE, PHENACETINE and congeners may be needed for pain.

PHOSPHORUS for pain and debility, $\frac{1}{100}$ to $\frac{1}{50}$ gr., 58; phosphide of Zinc recommended, $\frac{1}{10}$ gr. doses.

QUININE. SALICYLATES.

SILVER Salts (such as Protargol) in lotion, 3 to 6 gr. to the oz., 441-53.

ZINC Oxide and carbonate as protective lotions or ointments, 850; with Resorcin or other antiseptics or with anodynes.

HICCOUGH.

AMBER, Oil of, 5 to 10 m doses, as antispasmodic. CAJEPUT, do.

AMYL Nitrite. BELLADONNA.

BISMUTH as gastric sedative, or with magnesia. Brandy (hot).

BROMIDES. CANNABIS. CHLORAL. CHLOROFORM. COCAINE. ETHER.

Counter-irritation or pressure over phrenic nerve or stomach; also galvanism to same, or Faradism.

ERGOT. HYDROCYANIC Acid.

Ice to epigastrium, sometimes to ear. Inspiration, deep, prolonged, with raising of arms.

Lavage, emetics, or gastric sedatives.

MORPHIA, by the skin. PILOCARPIN.

PHENAZONE.

Shower bath. Tongue, forcible traction of, for 2 minutes (Laborde).

VALERIAN, Valerianate of Zinc, 855.

HOARSENESS.

ACIDS, especially Nitric, 340.

ALUM in gargle or spray, 404.

AMMONIUM Chloride in lozenge or vapour, 394.

BORAX in lozenge, with Chlorate or Cocaine, or in gargle, 825.

HOARSENESS (*continued*).

CAPSICUM, in gargle. GREASOTE vapour.

POTASH solution, 5 to 15 m doses,

SALT solution for bathing externally, and for compress, 214, 825.

SILVER Nitrate solution, 10 to 20 gr. to the oz., as paint, 458.

Steam, medicated with Benzoin, Terebene, etc.

SULPHUROUS Acid spray, 369.

TANNIN, as gargle or paint, with glycerin, acids, etc.

v. Laryngitis, Phthisis, Syphilis. (Aneurism and local growths have also to be considered.)

HODGKIN'S DISEASE.

v. Lymphoma.

HORDEOLUM.

BORIC Acid in lotion or ointment (1 to 5 per cent.), 299; also Carbolic.

Epilation of lash.

MERCURIAL ointments, yellow or red oxide, 3 to 6 gr. to the oz., or Ung.

Hyd. Am. Chlor. diluted, 1 in 4, 703.

SULPHUR, or Calcium sulphide, 39; Sulphocarbolates. Tonics.

HYDROA herpetiforme.

ARSENIC in full doses, as in Pemphigus, 523. BELLADONNA.

COD-LIVER Oil, food and hygiene.

COLCHICUM with Alkalies in gouty cases. QUININE.

Sedative baths, lotions, etc.

v. Pruritus.

HYDROCELE.

Acupuncture in infants; also evaporating or astringent lotions.

CARBOLIC Acid, 5 to 10 m injected (after emptying the sac), or a weaker solution for washing out.

COPPER Sulphate solution, 1 to 4 per cent., as injection, 602.

IODINE tincture for injection, 89; or IRON Perchloride tincture.

Incision or excision of the sac.

MERCURIAL ointment or oleate in early cases in children, 698, or Sublimite injection.

SILVER Nitrate to the inner lining of sac, or injected in solution, 461.

HYDROCEPHALUS, acute.

v. Meningitis, Convulsion.

HYDROCEPHALUS, chronic.

COD-LIVER Oil, internally and by inunction.

IODIDES, cf. 102-3. MERCURIALS, 705.

Surgical. Lumbar puncture.

HYDROPHOBIA.

BROMIDES (with Chloral, Morphia and other sedatives) for reflex spasms and insomnia, 148-53.

Cautery or caustic early to the wound.

CURARE in full doses.

OXYGEN, for threatened asphyxia, 9.

Pasteurism, or injections of serum (Tizzoni).

Vapour bath, 180.

v. Bites, Wounds.

HYDROTHORAX.

v. Pleurisy, Ascites, Nephritis.

HYPERIDROSIS.

v. Perspiration.

HYPERPYREXIA.

ACETANILIDE. ACONITE. ANTIMONY. Baths and spongings warm and cold, 197. Ice, 175-96.

PHENAZONE, PYRAMIDON and congeners sometimes useful.

PILOCARPIN, QUININE, in full doses.

v. Rheumatism, Typhoid, etc.

HYPERTROPHY, cardiac.

v. Heart, Palpitation, Nephritis.

HYPOCHONDRIASIS.

Alcohol, judiciously used with food.

ARSENIC, especially in the aged and melancholic, often with Iron, 517.

BROMIDES, Hydrobromic Acid to lessen excitement and irritability, but large doses apt to depress.

CIMICIFUGA, especially in uterine cases. Galvanism, central.

GOLD Chloride for cases with dyspepsia and cerebral anæmia, 538.

IRON for anæmia and debility, often suitably combined with the last, and with Bromides, 658.

Mineral waters, Sulphated and Muriated—Carlsbad, 237; Homburg, 248; for such causes as constipation, dyspepsia, hæmorrhoids, gout.

Moral treatment, occupation, travel.

PHOSPHORUS, Phosphoric Acid, in cases dependent on nerve or brain exhaustion, 59.

HYPOCHONDRIASIS (*continued*).

QUININE and STRYCHNINE, but not always well borne.

SILVER Nitrate, in cases due to overwork and anxiety, 468.

Spermin, Cerebrin, and similar organic remedies by mouth or skin.

SULPHONAL or other hypnotics required occasionally.

SUMBUL, calmative, not depressing.

Water in various forms of bath, Turkish, 181, douche and pack, 208; sea bathing, 213.

HYSTERIA.

AMMONIA for lassitude, fainting and distension; with Valerian for severe attacks, 395.

ASAFETIDA. GALBANUM.

BROMIDES, Hydrobromic Acid, combined with tonics, Camphor, etc., for spasmodic or sexual cases, not for ordinary conditions, 145.

CAJUPUT Oil, 1 to 3 m; Spirit, 10 to 20 m.

COPPER Sulphate in some weakly subjects, 603.

Galvanism, general. High-tension currents. Hydro-therapeutics.

GOLD Salts, especially the bromide, $\frac{1}{2}$ to $\frac{1}{4}$ gr. doses, 538.

IRON often required as part of the treatment, specially at puberty and the climacteric, 658.

Moral treatment.

Orchitic fluid, 15 m, increasing to 60, with sterilised water; or Nerve tissue emulsion, Cerebrin, etc., by skin, rectum or mouth.

PHOSPHORUS, Phosphoric Acid, useful in various forms, especially when menstrual troubles, 61.

Saline solution (Sodic sulphate 10, Phosphate 5, Water 100), by the skin (Luton), said to be equal to Spermine. VALERIAN.

Weir Mitchell treatment—Isolation, rest, overfeeding, massage—best for *thin* subjects.

ZINC Oxide, especially in combination; also valerianate or phosphide, 854.

v. Convulsion, Debility, Migraine, etc.

ICHTHYOSIS.

ARSENIC has been used, but is not dependable. COD-LIVER Oil.

COPPER Oleate in ointment has been recommended, 601.

Oil locally or Vaseline, Lanoline or Glycerole of Starch.

PILOCARPIN often useful.

SALICYLIC Collodion for destroying thickened skin, followed by Ung.

Ichthyol or Ung. Pot. iod.

THYROID preparations good.

Water, warm, vapour, or in prolonged alkaline mucilaginous baths, 205; or compress, 177.

IMPETIGO (Pustular Eczema).

SULPHOCARBOLATES. SULPHITES, 374. Aperients and tonics. v. Eczema.

IMPETIGO contagiosa.

MERCURIAL ointment (Ammoniochloride, 10 to 20 gr. to the oz.).

IMPOTENCE.

DAMIANA (fluid extract, 5i doses) may be given with Nux.

Electricity, with local Massage.

GOLD Chloride recommended, value not proved; suitable for traumatic cases when Mercurial perchloride or the Iodides are also indicated for a time.

IRON, especially phosphate or arseniate, with Strychnine, 625.

PHOSPHORUS, 60; also as Zinc and other phosphides, hypophosphites and glycerophosphates, 68. Phosphoric Acid, 354. Water, cold in local douche and sitz-bath, 203.

YOHIMBINE Hydrochloride (5 to 10 m of a 1 per cent. solution), lately recommended.

v. Debility.

INCONTINENCE OF URINE.

v. Enuresis.

INFLAMMATION.

v. Appendicitis, Endocarditis, Pleuritis, etc.; also Abscess, Fever.

INFLUENZA.

AMMONIUM Acetate, or citrate, for headache and pyrexia, carbonate for depression, 392.

ASPIRIN like Salicylates, but better borne, 15 to 20 gr. doses.

INFLUENZA (*continued*).

- CINNAMON Oil, 1 to 2 m hourly, tabloids, or tincture 3ss to ʒi, often relieve quickly and safely.
- CITROPHEN, a more soluble Phenacetin, 8 to 12 gr. doses.
- PHENAZONE, 5 to 10 gr. doses, preferably with Caffeine 1 to 2 gr., for headache and fever.
- POTASH Bicarbonate, or nitrate for pain and thirst, often effective.
- QUININE with Ammonia and effervescent alkali.
- SALIPYRIN, 10 to 20 gr. doses. Stimulants and feeding.
- SULPHUROUS Acid fumigation or inhalation, 573.
- Water, hot sponging for headache, also in bath and vapour, Turkish bath, 181.
- For complications, *v.* Debility, Catarrh, Pneumonia, etc.

INSOMNIA.

- ALCOHOL, ale or spirit in weakly subjects with feeble circulation.
- AMYLENE Chloral (Dormiol), 10 to 40 m (pungent) in mental cases, less depressant than chloral.
- AMYLENE Hydrate, do., do., 40 to 60 m in wine or spirit.
- BROMIDES, 20 to 30 gr. or more when cerebral hyperæmia from mental effort or anxiety, also during convalescence, 150; sometimes in dyspeptics, with other remedies.
- CANNABIS Indica, often combined with the last. CANNABIN tannate, 5 to 10 gr. (uncertain).
- CHLORAL Hydrate, 10 to 20 gr. or more, acts soon unless severe pain present; lowers temperature and vital functions.
- CHLORALAMIDE, 20 to 40 gr., less active than chloral, less depressant; often given with bromide; suits heart and bronchial cases.
- CHLORALOSE, 4 to 10 gr. (cachet), raises pressure, sometimes excites; for epileptic and mental cases.
- Electricity, static, also as weak constant or faradic currents to the head (*cf.* B.M.J., June, 1890).
- HYOSCINE Hydrobromide, $\frac{1}{100}$ to $\frac{1}{100}$ gr. in mental cases free from valvular disease.
- LUPULIN. MUSK in nerve exhaustion.
- OPIUM and its alkaloids.

PARALDEHYDE, ʒi to ʒij, unpleasant but effective for mental and heart cases, better than for lung or uræmic.

- SULPHONAL, 15 to 30 gr., acts slowly in powder, quicker in hot spirit and water, good for simple cases, apt to cause drowsiness next day.
- TRIONAL, 20 to 30 gr., more active, less soporific afterwards.
- URETHANE uncertain (20 to 40 gr.), HEDONAL (a methyl compound) better, 15 to 30 gr. effective in mild cases. URAL is Chloral urethane, dose 40 gr. SOMNAL is similar, with Ethyl, dose 30 gr.
- Vibration applied to head, also Massage. Hypnotism.
- Water, in bath, footbath with mustard, compress to epigastrium, 207.
- v.* Dyspepsia, Fever, Neurasthenia.

INTERTRIGO.

- ALUMINIUM silicate. (Cimolite, Fullers' earth), 411. Boric acid diluted, and other absorbent powders, 299.
- BISMUTH, ZINC Oxide and other pastes or ointments, 851.
- v.* Erythema.

IRITIS.

- ATROPINE or similar agents locally, to dilate the pupil; Cocaine may be added for pain.
- Counter-irritation near. Leeches. Hot fomentations frequently.
- IODIDES in rheumatic and syphilitic forms, 99; generally in the latter with Mercury, which also is used as ointment or collyrium, 716.
- SALICYLATES (Aspirin) in rheumatic cases. Surgical.
- TURPENTINE favours absorption.

IRRITABILITY.

- Anti-gouty treatment—aperients.
- BROMIDES, 151.
- Mineral Waters and baths as eliminant and sedative, 219.

ITCHING.

- v.* Prurigo, Scabies, Urticaria.

JAUNDICE.

- AMMONIUM Salts—chloride, 396.
- CALOMEL, grey powder, etc., in early stages, 718-20.

JAUNDICE (*continued*).

CHARCOAL, CREASOTE, and other intestinal disinfectants.

Diuretics to promote elimination.

Faradism over the gall bladder.

MAGNESIAN Sulphate with carbonate, or in mineral water (compound), 748-9.

MINERAL Acids, Nitric, 339, Nitrohydrochloric in later stages, 342.

OX-GALL. PILOCARPIN, preferably by the skin, for itching. RHUBARB.

SILVER Nitrate as relieving gastroenteritis and lessening mucus.

SODIUM Salts, carbonate, phosphate, salicylate, 830; Carlsbad, 237; Vichy, 229.

Water as hot sponging or pack, 204; also as alkaline baths, or tepid as copious enema.

v. Congestion, hepatic; Gallstones.

JOINT DISEASE.

v. Arthritis, Synovitis.

KELOID.

Electrolysis. Elastic pressure. Scarification. Thiosinamine (plaster-mull—Unna).

KERATITIS.

ATROPINE, Belladonna extract, Cocaine, or Eserine locally.

BORIC lotion, 299. Fomentations.

MERCURIAL ointments and lotions; Calomel insufflations, 703.

KERATOSIS pilaris. *v.* Ichthyosis.**LACTATION, excessive.**

BELLADONNA. OPIUM. POTASSIUM Iodide lessens secretion, 79.

LARYNGISMUS stridulus.

ANTIMONY in emetic doses, recommended, seldom advisable, 435.

BROMIDE, especially of Ammonium, with tonics, 146.

COD-LIVER Oil.

Water as bath, compress, douche or cold affusion, 193.

v. Convulsion, Rachitis.

LARYNGITIS.

ACONITE. Leeches.

ANTIMONY, in acute stages, 434.

Astringent sprays or gargles in chronic stages, Alum, 404; Iron, 635, Tannin, Zinc, 851.

CARBONIC Acid gas by inhalation or douche in chronic cases, 306.

COCAINE, gr. i ad $\bar{3}$ i, in spray or gargle in acute cases, and for a time only.

Compress, fomentation, or ice over thyroid; CARBOLIC Acid may be added, or BORACIC.

Faradism in chronic cases.

HEROIN, MORPHIA, etc., for cough.

IODIDES, especially in syphilitic cases, 99; Iodine by inhalation, and externally, 105.

MENTHOL, 5 per cent. in Paroleine, as paint or spray for subacute cases.

MERCURIAL inunction, or vapour from cigarettes in chronic cases (syphilitic), 702-16.

SILVER Nitrate insufflated, or in solution 20 gr. to 1 oz., 458.

Steam, simple in acute,—medicated with Benzoin, Eucalyptus, Terebene, etc., in chronic cases.

Surgical.

v. Aphonia, Hoarseness.

LARYNGITIS (tubercular).

Remedies as last, also IODOFORM insufflated or inhaled, 119. IZAL.

LACTIC Acid paint or spray, 40 to 80 per cent. MENTHOL, do., 1 in 10, later 1 in 5, of Oil.

SULPHUROUS Acid by spray or inhalation, 369.

v. Phthisis.

LEAD POISONING. *v.* Plumbism.**LEPROSY.**

Antiseptic ointments, Boracic, Carbolic, Chinosol, Iodoform, Pyrogallic, Salicylic, etc.

ARSENIC internally and externally.

CHAULMOOGRA Oil (Gynocardic acid), 1 to 3 gr. doses, and locally.

GURJUN balsam, locally and internally, $\bar{5}$ i to $\bar{5}$ ij doses in emulsion (like Copaiba).

MERCURIAL Sublimate intra-muscular injection or ointment, 697.

LEUCOCYTHÆMIA (Splenic leu-
kæmia).

ARSENIC, sometimes effective in full doses and subcutaneously, 481-508.

Cacodylates, *do.*, 531.

Bone marrow (red).

Galvanism of enlarged spleen.

IRON may be taken for a time with Quinine, *cf.* 644. Chalybeate water.

OXYGEN inhalation, 14. CARBONIC Acid, *do.* (W. Ewart).

QUININE, in malarial cases.

PHOSPHORUS of value in some cases, but not so much so as arsenic, 65.

For complications, *v.* Anæmia, Hæmorrhage, Ascites, etc.

LEUCORRHEA.

ALUM, generally with other astringents, 5 gr. to the oz., as injection after cleansing, 405.

BORACIC Acid in powder to fill the vagina for 24 hours, or in lotion or glycerin, 299.

BISMUTH as powder locally, or paste on lint, or injection (1 to 8), 553.

BROMIDES internally, in congestive cases, 146.

CARBOLIC Acid (iodised) to the cervix and canal.

CHROMIC Acid employed locally in 5 to 10 per cent. solution, 309.

COPPER Sulphate, 1 to 2 gr. to the oz., with Lead, or alternately, 601.

HYDRASTIS tincture injection, 1 to 2 dr. to $\frac{1}{2}$ pint.

IODINE tincture sometimes in full strength after cleansing, 88.

IRON tincture 1 dr., or sulphate 10 gr., to 10 oz., also internally, 635.

LEAD lotion in gradually increasing strength or with Zinc, 780; less irritant than Alum and some other astringents.

LIME Water as injection; the phosphate internally, 577.

Mineral waters: Muriated alkaline, 234,—Ems, La Bourboule; Muriated, 248,—Homburg, Kissingen, Kreuznach (if constipation); Chalybeate and baths of the same, 263 (if anæmia); Alkaline sulphated, 237,—Franzensbad (if uterus affected); “Indifferent” waters, 226,—Schlangenbad, Wildbad (for pain and hyperæsthesia).

OAK Bark, TANNIN. PULSATILLA, Tr. POTASH Bicarbonate, 1 dr., or chlorate, 2 dr. to the pint, especially in cervical cases; Permanganate, $\frac{1}{2}$ to 1 per cent. as deodorant, 798.

SILVER Nitrate, weak injections for vaginal cases, strong applications for uterine, 454.

SODA Bicarbonate and borax used like Potash salts; also the silicate. Water, especially in local sponging, hot douche and sitz bath, 174.

ZINC Sulphate, sulphocarbolate or chloride, 1-2 gr. to 1 oz.—stronger in chronic cases, 851.

LICE. *v.* Phthiriasis.

LICHEN simplex. *v.* Eczema.

LICHEN urticatus. *v.* Urticaria.

LICHEN ruber.

ANTIMONY in acute cases, 430.

ALKALINE baths, 216.

ARSENIC in full doses, 524.

PILOCARPIN.

v. Psoriasis, Prurigo.

LICHEN planus.

Remedies, as last, but ARSENIC only in chronic cases, 524; general tonics required, rest, change and nerve treatment; sometimes a Mercurial course, 697.

Hot douche daily over spine, followed by cold (Jacquet).

LICHEN scrofulosus.

Emollients, locally; Cod Oil internally.

LICHEN pilaris.

Do., with alkaline baths and frictions.

LITHIASIS.

ALKALIES, 802-80; Alkaline mineral waters, 229;—Vichy, Vals; Muriated, 248; sometimes Carlsbad, 237.

LIME Salts, 586; Earthy mineral waters, 288;—Contrexéville, Wildungen.

LITHIUM Salts, 737-8 (Thialion, Uricedin). Hot water drinking, 210. *v.* Gout, Calculi.

LIVER, fatty degeneration of.
SODIUM Chloride, 830.
v. Congestion, hepatic; Jaundice.

LOCOMOTOR ATAXY. v. Ataxy.

LUMBAGO.

Acupuncture in non-febrile cases.
ANTIMONY in obstinate cases in effective doses, for a short time, 428.
CIMICIFUGA. Counter-irritation, Corrigan's hammer.
Ether spray, Faradism, Galvanism, Electric or Turkish baths, 181-5; Heat, moist or dry, 178.
Frictions with Aconite, Belladonna, Capsicum, Chloroform, Menthol.
IODIDES with Potash salts, or Hydriodic Acid with Quinine, 100.
MORPHIA by the skin may be needed, or Cocaine.
Muriated mineral waters, 248;—Baden, Droitwich, etc.
PHENAZONE. QUININE. Rest.
SALICYLIC compounds often better than Iodides in acute cases.
SULPHUR with friction, also internally and in bath, 41-4; and mineral waters, 274.
v. Rheumatism.

LUMBRICUS. v. Ascarides.

LUPUS erythematosus.

ACETIC or Chloracetic Acid, 295.
BENZOLINE frictions, followed by sedatives or antiseptics.
CARBOLIC Acid, 1 in 10. Cod Oil.
Cautery (Paquelin). Collodion.
FOWLER'S Solution, 1 to 4, painted on till irritation produced, then soothing remedies, *cf.* 525.
ICHTHYOL in early stage.
IODINE in strong solution as paint, 96; as iodised Starch internally, 51 doses (Anderson), 71.
IODOFORM, 118. LACTIC Acid, 1 in 2, like Fowler's solution.
MERCURIAL ointments, dilute PHOSPHORUS, 64.
RESORCIN in paste or lotion, generally combined, as with Zinc oxide.
SALICYLIC paste, with Zinc, 851.
SOAP, Soft, tincture (1 oz. to 1½ oz. Spirit) in chronic, not active cases (may be diluted).

TAR (Liq. Picis), paint. Scarification.
ZINC Sulphide (the sulphate with Potassium sulphuret aa, 5ss, dissolve separately and mix with Spirit and Rose water to 3iv) (Duhring), 849.

Other remedies as below, but less actively, and with more frequent use of soothing lotions of Lead, Bismuth, etc.

LUPUS vulgaris.

ARSENIC, locally in caustic paste or oleate (10 p. c.), or weak solution, sometimes internally, 500-25.
BISMUTH or Boric Acid in lotion or ointment, as soothing or slightly stimulant, 299, 552.
CARBOLIC Acid as caustic (superficial only in action).
CHROMIC Acid in substance as caustic, cautiously, 309. Cod Oil.
IODINE, strong paint with glycerin in early stages, 96; sometimes internally, 103; also as a cleansing paste with Starch, 71.
IODOFORM in collodion, 118: preferably as ARISTOL, 10 per cent. ointment, 121; also Euphphen.
LACTIC Acid, full strength for ½ to 4 hours, or in paste with Kaolin.
LEAD lotion or cerate, for soothing.
Light, 186. Cautery. Operation.
Tuberculin.
MERCURY as plaster, or as acid Nitrate, or red Iodide, as caustic, 701; the Perchloride, 1 to 2 gr. to the oz., or hypodermically, in 1 per cent. solution.
NITRIC Acid, like acid nitrate of mercury—rather less effective, 337.
POTASH, Caustic, with equal part of water, in markedly strumous ulcerative forms, 797.
POTASH Permanganate, 10 per cent., in superficial subacute cases, painted on till part is crusted and softened, when it can be removed; or one application of the dry salt (after Cocaine), 758.
PYROGALLIC Acid ointment, 1 in 8.
RESORCIN paste or ointment, 5-20 per cent.
SALICYLIC Acid 1, with Creasote 2, simple ointment 2; or in Unna's plasters; or 10 per cent. with Mercuric oleate 5, in Zinc-Ichthyol paste (Brooke).

LUPUS vulgaris (*continued*).

SILVER Nitrate, solid to ulcerations followed by sedative applications, the double Iodide with Potassium, internally, 450-1.

SODIUM Ethylate solution as caustic paint, mild, often efficient; apply with glass rod daily for 2 to 3 days till crust formed, to be removed when loose (no water), 812.

CHLORINATED Soda solutions for cleansing, 160.

Soft soap or Soap spirit for softening and cleansing. Lysol, a tar soap (cresole and alkalis), antiseptic.

SULPHUROUS Acid vapour, or lotion 1 to 4, or with oil; or the nascent form, from a sulphite lotion applied at night, and an acid one in the day, 367.

THIOSINAMINE injections, 2 to 3 m of 15 per cent. solution.

ZINC Chloride or nitrate in paste as caustic; the carbonate and oxide in soothing lotion or ointment as required, 848.

LYMPHADENITIS.

ACONITE. Aperients. Fomentation, Compresses. Ice.

Alcohol lotion, 1 in 3, and as compress, warm.

CALCIUM Chloride, phosphate, sulphide, also lime water, 582.

CARBOLIC Acid painted, or injected.

IODINE to the glands and the part connected, 85; internally, 102.

IRON and QUININE as tonics and to control inflammation.

LEAD lotion. SULPHOCARBOLATES.
v. Gland, Abscess.

LYMPHADENOMA — LYMPHOMA (Hodgkin's disease).

ARSENIC sometimes successful by the mouth; has been injected into glands, 506.

Bone marrow. Gland extract. CALCIUM Chloride, *cf.* 582. Cod Oil.

IODINE and Iodides, locally and internally, the latter doubtful, because of depression, *cf.* 110.

PHOSPHORUS sometimes useful, not so often as Arsenic, 65. QUININE.

MALARIA.

v. Ague.

MAMMARY GROWTH OR ABSCESS.

v. Gland, Inflammation, Nipple.

MANIA.

ANTIMONY in moderate dose in acute cases, sometimes with Opium, 437.

Baths, warm foot, with cold affusion or douche. Turkish, etc., 207.

BROMIDES, sometimes in very large doses; apt to depress chronic cases, 152; specially good in puerperal forms, 153.

v. Alcoholism, Insomnia.

MASTURBATION.

v. Sexual.

MEASLES.

ACONITE in early pyrexia. ALKALIES, simple or effervescent, 805; often with acetate and other salts of AMMONIA, 392-3. NITROUS Ether.

ANTIMONY, especially when rash undeveloped, 427.

Antiseptic washes—mouth, eye, ear.

CALOMEL or Saline aperient, early.

GREY Powder in small frequent dose for catarrhal symptoms, 710.

Pack and other baths, 176-203.

PHENAZONE, also QUININE, for hyperpyrexia.

For complications see Bronchitis, Convulsions, Diarrhœa, etc.

MELANCHOLIA.

Baths, Douche, Light, Turkish, 207.

BROMIDES, act best in climacteric cases and during pregnancy, 145.

CIMICIFUGA for puerperal forms.

HYDROCHLORIC Acid, 320. PULSATILLA (female cases).

PHOSPHORUS and phosphoric acid sometimes valuable, 62.

v. Mania, Hypochondriasis.

MENINGITIS, Cerebral.

ACONITE. Leeches.

ANTIMONY as in fevers, also externally in ointment, but this is not to be recommended, 425.

BROMIDES in traumatic and also in tubercular cases, lessen convulsion, 154.

Cold to the scalp. Cold affusion, 170. Counter-irritation. Ice, 207.

IODIDES in basic and tubercular cases, with Iodide of Mercury frictions, 103.

MENINGITIS, Cerebral (*contd.*).

IODOFORM internally, and to the bare scalp in tubercular cases, 120.

MERCURY still sometimes used, and may be tried, but probably benefits only later stages by promoting absorption of exudations, 705.

PHENAZONE. Purgatives.

PHOSPHORUS internally and as an oily liniment to scalp, said to have cured tubercular cases, 63.

Puncture of Membrana Tympani in basilar cases.

MENINGITIS, Cerebro-Spinal and Spinal.

Remedies as last, but OPIUM more depended upon.

Lumbar puncture (on trial).
v. Myelitis, Spine.

MENIÈRES DISEASE. v. Vertigo.**MENORRHAGIA.**

ACID SULPHURIC, passive cases, 361.

ALUM, 2 dr. to a pint of boiling milk, strain and use as whey, 407.

ARSENIC, sometimes in full doses in congestive cases, 519.

BROMIDES in congestive cases, 146.

CALCIUM Chloride, especially at puberty or menopause, 20 gr. every 4 hours *per os*, up to 60 gr. *per rectum vel vaginam*; the carbonate in early cases, 585.

CANNABIS Indica. DIGITALIS.

Electricity, especially in fibroids (positive pole in uterus). ERGOT.

HAMAMELIS, HYDRASTIS, HYDRASTINE (alkaloid), $\frac{1}{2}$ -1 gr., dose.

HYDRASTININE, Hydrochloride, do. IODINE tincture, by intra-uterine injection, 88.

IRON Perchloride and sulphate in the young and anæmic, also at the climacteric, 630.

MAGNESIAN Sulphate, with Sulphuric acid or Iron sulphate, 751.

PHOSPHORIC Acid often acts well, 355, also Phosphorus, 61. QUININE.

Packing of uterus or vagina with antiseptic gauze in urgent cases.

Rest in horizontal position.

SILVER Oxide, especially when gastric complications present, 464.

SUPRARENAL extract, 5 to 10 gr., Adrenalin or similar solution.

Hot water bag over lumbo-dorsal region. Hot water douche, 189.

v. Uterine congestion.

MENTAGRA.

v. Syctosis.

MERCURIALISM.

ALUM in substance, gargle or mouth wash, and as preventive, 403.

HYDROCHLORIC Acid, in dilute lotion; also internally, 317.

IODIDES as rendering the mercurial salt more soluble, 97.

Mineral waters; Sulphurous, 274, and "Indifferent" thermal, 221, sometimes Sulphated, 237.

POTASH Chlorate and Permanganate locally, also internally, 799.

SILVER Nitrate said to be useful in mercurial palsy, 468.

SULPHUR in acute cases, also for later tremor and palsy, 42.

Water, copious drinking of, 209. Vapour and Turkish baths, 181.

ZINC Phosphide, for mercurial tremor, 855.

METRITIS.

v. Endometritis. Uterine Congestion.

MIGRAINE. v. Headache, Neuralgia.**MILIARIA.**

Weak antiseptic lotions and dusting powders.

v. Perspiration.

MILIARIA rubra (Prickly Heat).

v. also Pruritus.

MILIUM (*Strophulus albidus*).

Soap, and mild astringent antiseptic lotions. Incision. Electrolysis.

MITRAL disease.

v. Heart.

MOLLUSCUM contagiosum.

Electrolysis, Incision or Excision.

MERCURIAL Acid Nitrate, lightly applied, or Sublimate solution, 1 per cent. injected.

Mercurial-Sulphur ointment may abort in early stage.

SILVER Nitrate to lining membrane, but not often necessary,

SALICYLIC Acid collodion, 1 in 10, or SODIUM Ethylate (when very small), as under Nævus.

MUCOUS MEMBRANES, Irritable.

v. Catarrh.

MUMPS.

Fomentation and protection of gland.
GREY Powder in small frequent doses, 710.

Treatment for pyrexia and complications as required.

MYALGIA.

AMMONIUM Chloride one of the best remedies, 395.

Baths and Fomentations, 203.

BELLADONNA and other anodyne liniments and plasters.

CIMICIFUGA, and resinoid Cimicifugin, 1 to 6 gr. doses.

SALICYLIC compounds.

v. Lumbago, Neuralgia, Rheumatism.

MYELITIS.

BELLADONNA. ERGOT.

Cautery. Counter-irritation. Leeches or cupping in acute cases.

Electricity in later stages, 185.

Ice bags to the spine or preferably hot sand bags.

IODIDES or MERCURY as promoting absorption of exudates, inflammatory or specific, 102, 704.

PHOSPHORUS as restorative, *cf.* 59.

PHYSOSTIGMA extract, $\frac{1}{30}$ to $\frac{1}{20}$ gr.

SILVER Salts, in chronic ataxic cases, 467.

v. Spine; for complications, Bed-sore, Cystitis, Paralysis.

MYXŒDEMA.

Thyroid feeding, possibly Jaborandi, and vapour baths.

NŒVUS.

ACETIC Acid, glacial, 295.

Electricity, puncture with positive needle, from 5 to 10 Leclanché cells, negative pole on healthy skin.

IRON Perchloride applied on lint or injected, the latter method not free from risk, 634.

NITRIC Acid by needle puncture for small navi, or by painting on (with precautions), 338.

POTASH, Caustic, effective but painful; powdered nitrate in slight cases, 797.

SODIUM Ethylate painted on daily (with glass rod) till crust formed. No water to be used to the part during these applications, which may be renewed when the crust loosens and clears off.

ZINC Chloride, lint soaked in the deliquescent salt, 850.

NAILS (ingrowing).

Potash solution, 1 part in 3 to 4 of water, to the nail till softened and removed.

v. Onychia.

NAUSEA.

v. Dyspepsia.

NECROSIS.

v. Caries.

NEPHRITIS.

ACONITE, ACONITINE, in early stages, generally with diaphoretics, *e.g.*, Ammonium acetate.

AMYL and other nitrites, diuretic, lessen the pulse tension, spasm and dyspnoea of uræmia, 838.

ANTIMONY in acute cases, formerly recommended but is seldom serviceable, 435.

ARSENIC, good sometimes in acute, (especially post-scarlatinal), and sometimes in chronic, intermittent and mitral cases, 517.

ATROPINE, Belladonna, relieve symptoms and may lessen albumin.

Baths, Vapour, Hot, Blanket, Radiant heat, Turkish in acute and also in chronic cases, 180-4, 208; Douche (in the latter), cold, brief, followed by friction, 195; water drinking, 209.

Bleeding for pyrexia with bounding pulse, scanty urine and threatened coma or convulsion. Cupping over loins for pain or hæmaturia.

CAFFEINE as diuretic (in subacute).

CALCIUM Salts (soluble) and lime water in chronic and post scarlatinal cases, 586.

CANNABIS as hypnotic, often diuretic.

CANTHARIS in small doses as renal stimulant in some chronic cases.

CAPSICUM, counter-irritant to loins.

CHLORAL, CHLOROFORM, BUTYL Chloral, for special symptoms, neuralgia, etc., or with Bromide for convulsion, 143; may be given by rectum. ETHER for dyspnoea.

NEPHRITIS (*continued*).

COD Oil as nutrient in later stages.
 DIGITALIS generally suitable, best when pulse tension lowered.

FUCHSINE pure, in pill, $\frac{1}{2}$ to 2 gr. sometimes lessens albumin in subacute or chronic stages.

GALLIC Acid, do. do.

GOLD Salts in chronic cases, granular and fibroid, 538.

IODIDES in subacute and chronic cases (possibly syphilitic), 107.

IRON Waters or astringent preparations, with Ammonium acetate, Digitalis or Ergot, in subacute and chronic cases when free from headache or markedly high tension, 655.

OPIUM or its alkaloids, occasionally as anodyne, or by the skin in convulsive stages.

OXYGEN in later stages with anæmia and dyspnœa of uræmic origin, 15.

PILOCARPINE Nitrate, $\frac{1}{8}$ to $\frac{1}{4}$ gr., by mouth or skin as diaphoretic, cautiously; also by inunction.

POTASH Salts in combination as diuretic in the earlier stages, 810; later said to increase any tendency to uræmia (?).

PURGATIVES, such as Jalap and Magnesiansulphate, sometimes Elaterium.

SALICYLATES (ASPIRIN) in later stages lessen tension and pain.

SODA Salts for intercurrent dyspepsia, etc., 831; the Benzoate in threatened uræmia.

SULPHONAL or TRIONAL for restlessness and insomnia.

TRINITRIN, $\frac{1}{100}$ gr. or in smaller doses frequently, when tension high; acts for longer than Amyl.

TURPENTINE, in some chronic cases as renal stimulant.

For complications *v.* Dropsy, Heart Disease, Convulsion, Vomiting, Hæmaturia, etc.

NERVOUSNESS.

BROMIDES, 149; HYDROBROMIC Acid, 311.

v. Hypochondriasis, Hysteria, Debility.

NEURALGIA, NEURITIS.

ACONITE. ACONITINE. Acupuncture. Alcohol. Aquapuncture.

AMMONIA, liquor or liniment locally, 388; chloride or carbonate internally, 394.

ARSENIC good in many forms, especially facial and malarial, 509.

BELLADONNA and its alkaloid, mostly locally.

BROMIDES, chiefly in migraine, 144.

CANNABIS Indica. CAFFEINE.

CARBONIC Acid, jet or bath, 305.

Cautery. Counter-irritation (seton).

CHLORAL often with Camphor and Morphia, locally.

CHLOROFORM locally applied, or by deep injection.

CLOVES, Oil of, locally with friction.

COCAINE, do., or by injection under the skin, $\frac{1}{4}$ gr.

COLCHICUM in gouty cases.

Electricity, 204; Vibration.

GELSEMIUM (5th nerve cases, specially). GUAIACOL injected, 2 to 3 m, said to relieve quickly.

GLYCEROPHOSPHATES, 69. HYPOPHOSPHITES, compound.

IODINE locally, and in rheumatic, toxic and specific cases, internally; also IODIDES, 102.

IRON Carbonate, phosphate, citrate, perchloride, especially in the anæmic, 658. Chalybeate waters, 263.

Massage. Nerve stretching.

MENTHOL. OPIUM and its alkaloids.

OSMIC Acid, by the skin, 15 m of a 1 per cent. solution, in obstinate cases.

PHENACETIN, PHENAZONE and similar compounds, including METHYLENE BLUE and EXALGIN.

PHOSPHORUS in cranial, intercostal, anginoid and uterine cases, sometimes when dependent on local irritation (teeth, etc.), 57.

PRUSSIC Acid and Cyanides locally, in some cases internally, 332.

QUININE, full doses in periodic forms.

SALOL and Salicylates (Aspirin).

SILVER Nitrate solution, deeply injected in chronic cases, 462.

STRYCHNINE. TONGA (5th nerve).

SULPHUR baths and waters in rheumatic cases, 274.

Water in fomentation, douche and other baths, 179.

ZINC Valerianate in neuralgic headache and uterine cases, 855.

v. Alcoholism, Dyspepsia, Gout, Uterine disorders, etc.

NEURASTHENIA.

SPERMINE injections, 15 m doses (Poehl).

v. Debility, Hypochondriasis, and special symptoms, as Dyspepsia.

NIGHT TERRORS, NIGHTMARE.

BROMIDES, especially in children, as lessening reflex, 152.

v. Dyspepsia.

NIPPLE, SORE.

Antiseptic spirit lotions as preventive, *e.g.*, Red Iodide of Mercury 1 gr. Spirit of Wine $\frac{1}{2}$ oz., Glycerin 4 oz., Water to 10 oz. (Lepage).

BISMUTH in ointment or oleate, generally with Benzoin, 552.

BORACIC Acid or BORAX, in lotion, glycerin, or spirit of wine, 826.

CARBOLIC Acid lotion. COLLODION. HYDRASTIS lotion, 1 to 2 dr. Tr. to half pint.

LEAD Nitrate, 10 gr. to the oz. of glycerin, with precaution as to suckling, 779-80.

LIME Water with oil (Lin. Calcis).

SILVER Nitrate, fine point of, to touch lightly after cleansing, 460.

SULPHUROUS Acid in compress, full strength unless skin broken, 368.

TANNIN and astringents doubtful, as hardening.

NODES.

v. Syphilis.

NYMPHOMANIA.

Baths in various forms, 173-4.

BROMIDES in full doses, 153. Moral or Asylum treatment.

SALIX Nigra, fl. ext. $\frac{1}{2}$ to 1 dr. doses.

OBESITY.

v. 910 last line.

ACETIC Acid acts by causing gastric catarrh—not advised, 294.

ALKALIES, especially liq. Potassæ, 809. Diet Exercise.

FUCUS Vesiculcus, not dependable.

Hydro-therapeutics, 173-210. Turkish bath, 181. Callerman. Radiant Heat or Electric baths, 184.

IODIDES in full doses impair nutrition, 81.

Mineral waters—Alkaline, 229; Sulphated, 237; Bitter, 241; Muriated, 248, or Sulphur, 274, in fat

anæmics with diminished metabolism; sometimes gaseous Chalybeate, 264.

THYROID extract, with caution as to palpitation, syncope or pyrexia.

OBSTRUCTION of BOWEL.

MAGNESIAN or SODIC Sulphate, full doses, freely diluted, 748, 833.

BELLADONNA as anti-spasmodic, $\frac{1}{4}$ to 1 gr. 2 to 4 hourly; often with OPIUM, $\frac{1}{2}$ to 1 gr. (Brinton), or with alkaloids of the same

v. Constipation, Appendicitis, Peritonitis.

CEDEMA, general.

v. Ascites.

CEDEMA GLOTTIDIS.

SILVER Nitrate in strong solution, locally, 458.

v. Angina, Laryngitis.

ONYCHIA.

BORIC ointment, 299.

CARBOLIC Acid lotion, with spirit.

CHLORAL lotion, 4 to 5 gr. to the oz. IODOFORM, Arstol, Loretin, etc., in powder or ointment, 119-21.

IRON Perchloride or persulphate in ointment, 637.

LEAD Nitrate in powder, 780.

LIME, caustic, in severe cases, 573; internally as sulphide, 39.

MERCURIAL Oxides in lotion; or ointments in intervals of poultice, 700.

SILVER Nitrate solution, 30 gr. to the oz. of Nitrous ether, as paint, 459.

Water in fomentation and compress, 177, with antiseptics. Incision.

v. Abscess.

OPHTHALMIA.

ANTIMONY in acute purulent and strumous cases, more used formerly, 429.

ARSENIC internally in strumous cases, especially when herpes present 506. BORIC lotion, 299.

CADMIUM Sulphate as astringent lotion or ointment, 4 gr. to oz., 562.

ODOFORM, Iodol and congeners, in ointment, 122.

LIME, weak solution of chloride, 577.

MERCURIAL Perchloride in weak, warm lotion for strumous and catarrhal cases, 703.

OPHTHALMIA (*continued*).

NITRIC Acid internally, in purulent cases with corneal ulcer, 340.
SILVER Nitrate, Protargol, etc., 456.
SULPHUR as Calcium sulphide, 39.
ZINC Chloride lotion, 851.
v. Conjunctivitis.

OPIUM POISONING.

Emetics by mouth or skin.
CAFFEINE, ATROPINE, STRYCHNINE.
POTASH Permanganate, about 8 gr. in 8 oz. of diluent, 758.

ORCHITIS.

ACONITE. Leeches.
AMMONIUM Chloride as cooling absorbent lotion, 389.
ANTIMONY in small frequent dose, 429; has been used in ointment locally, 425.
BELLADONNA extract with glycerin.
Cold by compress, Leiter's tubes, or Ice. Collodion. Fomentations with poppy, etc.
GUAIACOL, 5 per cent., with vaseline.
IODINE lotion, liniment or ointment, for after effects,—with strapping, 87; also Iodides internally, 110. IODOFORM, 118.
LEAD lotion in acute stages, with Opium. PULSATILLA.
MERCURIAL Oleate painted, or ointment gently rubbed in, for subacute cases, 697, or as suppository: a mild mercurial course in chronic cases.
OPIUM. SALICYLATES, perhaps with Colchicum Saline aperients.
SILVER Nitrate, strong solution locally, or over adjacent vessels, 461.

OSMIDROSIS. v. Perspiration.

OSTEOMALACIA. v. Fracture.

OTITIS, OTORRHEA.

ALUM injection, 4 to 6 gr. to the oz., in subacute or chronic stages after cleansing, 464.
BORIC Acid do., 6 to 10 gr. to the oz., or insufflated in powder, 299.
IODOFORM insufflations, 117, after FORMALIN injections, 2 to 4 p. c.
LEAD Acetate in "drops" or injection, gradually increased strength, 780.
LIME Water or chloride as injection, and compress over ear at night, 577.

PEROXIDE locally, in about 4 per cent. solution, 23.

POTASH Permanganate in weak solution, *cf.* 799. PULSATILLA Tr., dilute.

SILVER Nitrate in strong solution, to tympanum, combined with antiseptic washes (Carbolic, Iodine, Spirit, etc.), for chronic cases, 456.

ZINC Chloride, sulphate or sulphocarbolate, in "drops" or lotion, 1 or 2 gr. to the oz., sometimes combined with Lead, 851. Surgical.

OVARITIS, Ovarian congestion.

ACONITE in acute cases. Leeches.
ANTIMONY Tartrate in ointment, as counter-irritant, 426.
BELLADONNA. Blister in later stages.
BROMIDES relieve hysterical restless conditions, 149; and lessen growths, 155.
CANNABIS. CAMPHOR. CHLOROFORM. Hot applications *per vaginam*, and externally.
IODINE locally and internally, to lessen congestion and promote absorption; Iodides also, in chronic cases, 110.
MERCURIAL ointments, generally used with Belladonna, 698.
Mineral waters: Muriated, 248; Muriated Alkaline (Ems), 234; sometimes the "Indifferent," 221; in chronic cases, Iodo-bromated, 221; and Moor-baths, 241.
OPIUM and alkaloids for severe pain.
PHENACETIN, PHENALGIN, PHENAZONE, etc. PULSATILLA.
Saline aperients.
Treatment for displacements, ulceration, etc., Surgical.
v. Cysts, Endometritis.

OXALURIA.

HYDROCHLORIC or Nitro-hydrochloric Acid, till digestion improved or urates excessive, 320-43.
PHOSPHORIC Acid used similarly, 354.
POTASH Salts sometimes, when gastric irritation present.
v. Dyspepsia, Hypochondriasis.

OZÆNA.

ARISTOL insufflations, 121.
βNAPHTHOL, BORIC, CARBOLIC, FORMALIN (1 in 500), or HYDRASTIS as lotion or injection.
BROMINISED inhalations, 125.

OZCENA (*continued*).

- IODINE lotion with Salt, 95.
 IODOFORM in snuff, bougie, or on pledgets of wool, 118.
 MERCURIAL Oxides, as "black or yellow wash," for nasal injection, 702.
 PERUVIAN balsam locally.
 POTASH Permanganate douche, 1 to 2 gr. in the oz., *cf.* 799.
 SANITAS, TANNIN, ZINC Chloride, 851, and similar lotions.

v. Otorrhœa.

PALPITATION (mainly functional).

- ACONITE. ADONIS, infusion $\frac{1}{2}$ oz.
 Adonidin, $\frac{1}{4}$ to $\frac{1}{2}$ gr.
 BELLADONNA.
 BROMIDES in nervous and gouty forms, 148.
 CAFFEIN. CAMPHOR. COCA.
 CEREUS (Cactus grandiflorus) tincture, 5 to 20 m.
 Continuous currents to vagus and heart region.
 CONVALLARIA tincture, B.P.C., 5 to 20 m, allied to Digitalis, less liable to nauseate.
 DIGITALIS. HYDROBROMIC Acid, 311.
 MORPHIA for pain, but rarely best.
 PRUNUS Virginiana tincture, $\frac{1}{2}$ to 1 dr.
 PRUSSIC Acid, 334, Cherry laurel water, $\frac{1}{2}$ to 2 dr.
 SILVER Salts have been recommended, 469.
 See also possibly Dyspepsia, Anæmia, Exophthalmos, Angina.

PARALYSIS, Cerebral and Spinal.

- ANODYNES, if required.
 Baths, douche, 172; electric, 185.
 COCCULUS IND. tinct., 1 to 5 m.
 Picrotoxin, $\frac{1}{8}$ to $\frac{1}{2}$ gr. in hysterical and bladder cases.
 ERGOT for congestive cases and bladder symptoms.
 Galvanism and Massage.
 IODIDES in chronic stages promote absorption, 102.
 MERCURIALS, *do.*, *cf.* 705-14.
 STRYCHNINE in chronic stages.
v. Apoplexy, Myelitis, Paraplegia, Sclerosis.

PARALYSIS agitans.

- Nerve tonics and sedatives, ARSENIC, CANNABIS, HYOSCYAMUS.
 HYOSCIN Hydrobromide, $\frac{1}{200}$ to $\frac{1}{100}$ gr., best by the skin.
 VALERIAN.

PARALYSIS, facial (peripheral).

- Counter-irritation.
 Electricity in whichever form causes contraction of muscles, but not too early, nor in excess.
 PILOCARPIN (third nerve cases).
 STRYCHNINE. QUININE.
 (If from middle ear disease, that must be treated).
v. Diphtheria, Neuritis, Ataxia.

PARALYSIS (Landry).

- Cautery over spine (some cases).
 IODIDES as eliminant. Nourishment.
 SALICYLATES.
 Vapour baths.

v. Myelitis, Neuritis.

PARALYSIS (Lead). *v.* Plumbism.**PARAPLEGIA.**

- PHYSOSTIGMA Ext., $\frac{1}{4}$ to 1 gr.
 ESERINE Sulphate, $\frac{1}{60}$ to $\frac{1}{20}$ gr.
 (half dose by the skin), in myelitis and ataxic cases.
 RHUS. Tox. tinct., 3 to 10 m, and for bladder symptoms.
v. Paralysis.

PAROTITIS. *v.* Mumps.**PEDICULOSIS.** *v.* Phthiriasis.**PELVIC CELLULITIS.** *v.* Abscess.**PEMPHIGUS.**

- ARSENIC in chronic recurrent cases, especially children, 522.
 Baths, warm emollient, 205.
 BORIC or CARBOLIC Acid compress, or ointment, 299; Galvanism in the foliaceous form.
 LEAD Acetate, ZINC Oxide, and other sedative or anti-pruritic lotions, powders or ointments—Lin. Calcis (*v.* Eczema).
 MERCURIAL frictions (oleate) in syphilitic or obstinate cases, 349.
 POTASH Chlorate, QUININE, COD-LIVER Oil, in the foliaceous form.
 RHUS Tox. tincture, 3 to 10 m.
 SULPHIDES or Sulphocarbolates if pustulation occurs.
v. Dermatitis.

PERFORATING ULCER of foot.

- Galvanism. Stimulation locally.
 Nerve stretching. *v.* Ataxy.

PERICARDITIS.

ACONITE in early stages. Leeches. Alcohol later. Blisters. BRYONY for effusion. DIGITALIS cautiously, often with Strychnine. Ice-bag or warm compress. IODINE locally, internally, and by injection after aspiration of sac, 91; also Iodides, 100. MERCURY, in subacute or chronic cases, with effusion, 706. OPIUM. QUININE. SALICYLIC compounds. v. Rheumatism.

PERIOSTITIS.

ACONITE. Leeches in acute, blisters in subacute cases. DELPHINIUM, Tr. m x, in rheumatic. IODINE and Iodides locally and internally, 100. MERCURIALS, do., cf. 699. OPIUM. Spirit lotion in slight cases (traumatic).

PERITONITIS.

ACONITE in early stages. Leeches. Alcohol later. Ice. CASTOR Oil sometimes at commencement. CHLORAL. COCCULUS IND. tinct., 1 to 5 m, for tympanitis. Counter-irritation. Enemata. Ice. IODINE and IODIDES in chronic cases, locally and internally, 87. MAGNESIAN Sulphate in early stages, especially after operations, 750. MERCURY in small doses in acute cases with Aconite or Opium, 707; or one full dose of Calomel at commencement, 707. OPIUM and its alkaloids. Operation, especially in chronic tuberculous or perforative cases. Poultice or hot fomentation with TURPENTINE, which also may be given for tympanitis. In puerperal cases, antiseptic injections. STRYCHNIA by the skin in later stages, or for collapse. v. Appendicitis, Fever, puerperal; Tuberculosis.

PERSPIRATION, excessive, general.

ACETIC Acid, dilute, warm, for sponging night and morning, 296. AGARIC, $\frac{1}{4}$ to 1 gr. in pill. ALUM, especially the oleate, 349. ATROPINE, $\frac{2}{100}$ to $\frac{1}{100}$ gr. BELLADONNA locally and internally.

BISMUTH in dusting powder, generally combined, e.g., with Starch, Tannoform, or BORACIC Acid, 1 in 8, and SALICYLIC, 1 in 16. CAMPHORIC Acid, 10 to 20 gr. at night in phthisis. Diet, dry. ERGOT. Electricity. Hydro-therapeutics. LIME water locally, phosphate internally, 576-83. Oil inunction. PICROTOXIN, $\frac{1}{10}$ gr. dose. QUININE with Sulphuric acid, or the latter alone, 362. SULPHONAL, 3 gr. twice daily, recommended. SULPHUR, 1 dr., more or less, in milk twice daily (Crocker). ZINC Oleate, locally (with Thymol), oxide internally, 853.

PERSPIRATION, local, often foetid.

Emplastrum Plumbi, to strap feet daily after cleansing, till skin exfoliates. Disinfectant baths, with Sulphites, Permanganates, or Sublimate. Disinfectant paints, Naphthol, 3 per cent. Salicylic acid, 5 per cent. in alcohol. Disinfectant powders, Alum, Boracic acid, Charcoal, Tartaric acid, Resorcin 1 in 20, with Chalk or Starch as diluent, Soda Salicylate, or Permanganates. CHROMIC Acid, 5 p. c. if skin not broken (has caused nephritis), 309. HYDROCHLORIC Acid to thick skin of soles and heels for 10 minutes, or till painful, then wash; repeat twice weekly till skin exfoliates (for severe cases). SILVER Nitrate solution, 10 per cent., like Hydrochloric acid. TANNOFORM powder very good, or ointment, 10 per cent. Water, hot, followed by Eau de Cologne with 1 to 2 per cent. of Quinine (for axillæ). ZINC Chloride, 6 per cent. solution. Zinc-Ichthylol plaster if surface inflamed.

PERTUSSIS.

ALUM in the later stages when secretion profuse and spasm severe, 410. AMMONIUM vapour, also chloride or sulphide by inhalation, 394; Bromide internally, 146.

PERTUSSIS (*continued*).

AMYL Nitrite relieves spasm.
 ANTIMONY in small frequent dose for intercurrent bronchitis, 431.
 ASAFCETIDA often useful.
 BELLADONNA, ATROPINE $\frac{1}{100}$ to $\frac{1}{10}$ gr.
 BROMOFORM, drop doses 3 hourly.
 CARBOLIC or CRESYLIC Acid, by spray, inhalation or nasal irrigation.
 CAMPHOR, compound tincture.
 CHLORAL, BUTYL-CHLORAL, CHLOROFORM, CANNABIS, CERIUM, CONIUM.
 Compressed air, 11. Counter-irritants.
 ERGOT, specially if epistaxis.
 EUCALYPTUS. FORMALIN VAPOUR.
 HENBANE.
 HYDROCYANIC Acid, for the nervous element specially and for vomiting, 333. Cherry-laurel Water.
 IPECACUANHA. LOBELIA.
 NITRIC Acid dilute, lessens spasm and expectoration, but may injure teeth, 341.
 OIL of AMBER. by friction and internally. OPIUM and its alkaloids (Heroin). PEROXIDE, 24.
 PHENAZONE good in early stages with Bromides.
 POTASH Salts, bromide, carbonate, acetate, sulphuret (freshly prepared), 807.
 QUININE, in pyrexial cases or later stages, but lessens secretion.
 RESORCIN, 2 to 5 per cent. spray or solution applied to fauces, very useful; also internally.
 SILVER Nitrate solution to fauces, 457; Iodide internally, 469.
 SALICYLIC Acid in spray as antiseptic. SQUILL. SUMBUL.
 SODIUM Benzoate with Ammonium chloride (Yeo).
 SULPHUR fumes in bedroom during absence of patient, 370.
 TANNIN to fauces. TAR, TEREBENE or THYMOL vapour or spray.
 VALERIAN. VIRGINIAN PRUNE, Tr.
 ZINC Oxide or sulphate, usually with Belladonna, 854.
 For complications, *v.* Bronchitis, Convulsions, etc.

PHAGEDÆNA. *v.* Ulceration.

PHARYNGITIS, acute.

ACONITE, compress, etc., as under Tonsillitis. Weak CARBOLIC paint,

gargle or spray, with COCAINE, GLYCERIN and BORAX; the same in lozenge.

MENTHOL, 5 per cent. in Paroleine, as paint or spray. Astringent applications later.

SALOL or SALICYLATES.

PHARYNGITIS, granular.

Remedies as last, but change of air important. Sea voyage. Tonics. TRICHLORACETIC Acid (after Cocaine) or Galvano-cautery, to destroy granulations in chronic cases. SILVER Nitrate or IODINE tincture on stiff brush with friction till bleeding (twice at intervals). BROMIDES locally, sometimes internally. HYDRASTIS, do.

(Tobacco to be *avoided*.)
v. Throat, catarrhal.

PHLEBITIS, PHLEGMASIA alba.

ACONITE with Salines, possibly Morphia in acute stage.

HAMAMELIS, locally and internally. Fomentations, but not always good. Cotton wool packing and bandage better, the limb being raised. Strapping in later stages, and Massage for chronic œdema. Blister over lymphatics or Iodine. BELLADONNA ointment, or GLYCERIN of LEAD and OPIUM lotion, with spirit.

Leeches sometimes useful.

IODIDES with AMMONIA as solvents of clot, *cf.* 391.

IRON, sometimes with Digitalis.

MAGNESIA or SODA Sulphate.

QUININE. Surgical. Uterine disinfection in puerperal cases.

PHOSPHATURIA.

BENZOIC Acid and its compounds. Diet, etc.

PHOSPHATE of Sodium (acid).

NITRIC Acid, 339, PHOSPHORIC, 354.

v. Cystitis (triple phosphates), Dyspepsia (earthy phosphates).

PHOSPHORUS Poisoning.

Antidotes, Copper, Turpentine, 56.

PHOTOPHOBIA.

v. Conjunctivitis, Iritis, etc.

PHTHIRIASIS.

ACETIC Acid lotion for removing "nits" from the hair, *cf.* 263.

CARBOLIC Oil or lotion, 1 in 20, a few applications. CHLOROFORM locally.

COCCULUS Ind. in ointment or tincture, 1 part in 2 of water, for sponging.

Disinfection of clothes. ETHERS spray.

MERCURIAL ointments, red oxide, or ammonio-chloride or oleate (5 per cent.), with an equal part of ether; or perchloride in glycerin ($\frac{1}{2}$ gr. ad $\frac{5}{16}$), or with spirit and water, or vinegar, 693. Naphthol.

PETROLEUM, with oil or ointment, 1 in 2, a good preventive.

Soaps, sulpho-naphthol, sublimate, etc. STAPHISAGRIA ointment.

PHTHISIS, pulmonary.

ANTIMONY, especially in early stages when congestion and pain present, 434; also as ointment, 425.

ATROPINE or BELLADONNA for special symptoms. sweating, pain, etc.

ARSENIC for early stages before softening, and for slow cases, also in cigarette, 504-5.

CACODYLATES, 531.

BORIC Acid (preventive in animals), 15 gr. doses recommended, 300.

BROMIDES relieve cough, vomiting, and dysphagia; the Calcium salt good for diarrhœa, 150.

CARBOLIC Acid. CETRARIA. CHERRY Laurel water.

CHLORINE inhalation, 162. CHLORAL. COCAINE.

Cod Oil. Counter-irritation over chest.

CREASOTE and its compounds, GUAIACOL and its carbonate (Duotal), Creasotal, Thiocol, etc.

DIGITALIS with QUININE in some pyrexial cases. EUCALYPTUS.

FORMALIN inhalations, 4 to 6 per cent., 105.

HETOL (sodium cinnamate), $\frac{1}{8}$ gr. increased to $\frac{1}{2}$ gr. by intravenous or gluteal injections, in non-febrile cases, with antiseptic precautions. (Landerer).

HYDROCYANIC Acid palliates cough, sickness, and dyspepsia, 333.

HYPOPHOSPHITES, PHOSPHORUS, relieve some symptoms and improve nutrition, 63; also Phos-

phoric acid, 354, and Nuclein, $\frac{1}{2}$ gr. by the skin, 4 hourly.

IODINE tincture externally, in vapour, and by the mouth; also IODIDES, 87-105; best for chronic cases without hæmoptysis.

ODOFORM internally, and by spray, vapour and insufflation, 118-19.

Kefir, Koumiss (digestible nutrients).

IRON Iodide, sometimes the astrigent salts, if well borne, 653.

LIME Water, carbonate, phosphate, and chloride, lessen discharges, and improve nutrition, 533.

MALTINE. MENTHOL ($\frac{5}{16}$ of 10 per cent. solution in oil, for intralaryngeal injection).

Mineral waters: Arsenical, 271 (Bourboule, Mont Dore); Sulphur (Pyrenees), 274; Earthy (Weissenburg), 289.

Mullein decoction, with milk.

NITROGEN, with 2 parts air for inhalations in early stages (antipyretic), 18; also pure for intrapleural injection (Murphy).

OPIUM, Morphia, Codeia, Heroin hydrochloride, $\frac{1}{16}$ to $\frac{1}{8}$ gr.

OXYGEN, Open-air treatment, 12.

PHENAZONE, Phenacetin, etc.

PICROTOXINE, $\frac{1}{16}$ to $\frac{1}{8}$ gr. for night sweats.

POTASH Bicarbonate and Chlorate lessen pain and sputum, often given with cough sedatives; tellurate lessens sweating, 807.

SALICYLIC compounds (antiseptic, antipyretic). Sera, various, injected.

SODIUM Chloride with syrup or in goat's milk, 832.

SULPHUR, internally and in vapour—more used formerly, 41.

SULPHURETTED Hydrogen as in the Weilbach waters, 278; and by rectal injections (obsolete), 26.

SULPHURIC Acid, in pyrexial cases with undue discharges, 362.

SULPHUROUS Acid, internally and in spray, disinfects and lessens expectoration, 370.

THYMOL. Tuberculin injections.

UREA, 2 to 4 dr. daily. Nitrogenous foods. Raw meat and juice.

Water as in sponging, compress, cold douche, sea-bathing, 195-211. ZINC Oxide for night sweats—also for diarrhœa, 852-3.

For complications, *v.* Hæmoptysis, Diarrhœa, Dyspepsia, etc.

PILES.*v.* HÆMORRHOIDS.**PITYRIASIS Capitis.**

Glycerin.

v. Seborrhœa.**PITYRIASIS rubra.**

ACONITE or ANTIMONY in small frequent dose, 480.

Baths — alkaline, mucilaginous or with tar, etc., 216.

IRON Perchloride tincture, 636.

LEAD or ZINC lotions or oils, 779.

OPIUM as sedative.

PILOCARPINE often useful, promoting fluid secretions.

POTASH Citrate in effervescence (with Quinine).

Thyroid Extract often relieves for a time, if not curative.

v. Pruritus.**PITYRIASIS versicolor.***v.* Chloasma.**PLEURISY.**

ACONITE, ASPIRIN, Aspiration for effusion. Leeches.

AMMONIUM Acetate or Citrate relieves pain and pyrexia, 392-3.

ANTIMONY do. do. more active, but with more tendency to depression, 431.

BELLADONNA locally. Blister to promote absorption.

BRYONIA tincture, 5 to 10 m, limits exudation when pyrexia lessened.

CAFFEIN, DIGITALIS, as diuretics. Cold compresses, Ice bag.

Heat—fomentations, poultices, etc.

IODINE locally to relieve pain and promote absorption, also sometimes injected after aspiration, 87; Iodides internally, *cf.* 107.

IODOFORM Collodion, 1 in 20, often better than Iodine, 118.

IRON, reduced, Perchloride or Acetate in chronic effusion, 655.

MAGNESIAN Sulphate in full doses, in chronic effusion (limiting the fluid taken), 752.

MERCURY sometimes by friction for effusion, better by the mouth,—in moderation, 698, 707.

MORPHIA for pain and cough, generally by the skin.

OXYGEN and compressed air to relieve dyspnoea and promote expansion, 11.

PHENACETIN and congeners for pain and pyrexia.

SALICYLATES, SALOL, often useful.

PLEURODYNIA.

Remedies as above. CIMICIFUGA.

Continuous current. CHLORAL-CAMPHOR and other anodyne paints and plasters. BELLADONNA. MENTHOL. Strapping.

PHOSPHORUS valuable, 58.

v. Rheumatism, Neuralgia.**PLUMBISM.**

ALUM in many cases has relieved pain and constipation, 409.

Galvanism in bath and otherwise, to spine and affected muscles, 165.

IODIDES increase solubility of deposited lead and promote elimination, 98; generally combined with MAGNESIAN Sulphate or aperient Waters, 748.

OPIUM, Morphia, etc., as required.

SULPHUR in full doses has relieved, but is almost superseded by Iodides, 42.

SULPHURIC Acid, as antidote and prophylactic, but this is not well corroborated, 362.

Vapour and other baths, 180; Fomentations, 179. Water-drinking, 209.

PNEUMONIA.

ACONITE. Leeches. Alcohol freely in later stages only, with weak, quick pulse. ETHER.

AMMONIUM Acetate, citrate or carbonate; chloride in later stages, 393.

ANTIMONY in small frequent dose in early stages; with caution in children, 431.

CAFFEIN in later stages, as heart stimulant. CINCHONA.

Cold baths or spongings for pyrexia, 193. Compresses, 177.

DIGITALIS, in full doses in early stages if at all (one pint of infusion in 24 hours is the best form).

Ice-bag locally, sometimes better than heat.

IPECACUANHA in combination.

IODIDES in full doses in early stages (not generally adopted), 105.

MERCURIAL Subchloride as purge—Perchloride later promotes resolution, 708.

MORPHIA occasionally, as required.

PNEUMONIA (*continued*).

OXYGEN, 13. QUININE, in full doses.
 PHOSPHORUS, especially when weakness marked, and also when hepatisation complete, 62.
 SALICYLIC Compounds.
 Saline solution injected (6 to 12 oz.).
 SENEGA, SERPENTARIA, in later stages and asthenic cases.
 STRYCHNIA, for cardiac failure.
 SULPHONAL, for insomnia.
 TURPENTINE. Steam inhalation.

POLIOMYELITIS.

v. Paralysis, spinal.

POLYPUS NASI.

Alcohol lotion.
 ALUM, in strong solution locally or by insufflation, 405.
 Cautery. Operation.
 CHROMIC Acid, 309.
 TANNIN, ZINC Sulphate or other astringents, 851.

POLYURIA. *v.* Diabetes insipidus.**POSTPARTUM HÆMORRHAGE.**

Hot water injection, 189.
 IRON solutions by injection, 632.
v. Hæmorrhage.

PRICKLY HEAT. *v.* Pruritus.**PROCTITIS.** *v.* Rectum.**PROGRESSIVE MUSCULAR ATROPHY.** *v.* Paralysis.**PROLAPSUS ANI, vel VAGINÆ.**

ALUM for bathing and injection, or by tampon with glycerin, 405.
 HYDRASTIS *do.* *do.*
 Ice, if inflamed.
 NITRIC Acid internally, or in weak lotion, or in full strength as caustic (in bands), 338.
 OAK BARK. OPIUM. PODOPHYLLIN.
 SULPHUR or SENNA confection as suitable aperients, 42.
 STRYCHNINE. TANNIN, in various forms, locally. Surgical.
v. Hæmorrhoids.

PROSTATITIS, also hypertrophy.

ADRENAL-extract suppositories, with an anodyne in acute cases.
 AMMONIUM Chloride when vesical catarrh, sometimes the citrate, 397.
 Counter-irritation or Cold to perineum in chronic cases; also to thighs.
 ICHTHYOL, 10 gr. in suppository.
 IODINE in suppository, and sometimes injected into gland, 87.
 IODOFORM ointment, 118. Leeches.
 Massage of prostate. Surgical.
 Saline purge. Water, hot rectal injections, sometimes cold.
v. Cystitis, Retention, Enuresis.

PRURIGO, PRURITUS.

ACONITE in acute dermatitis.
 ALKALINE lotions with Soda salts, Potash solution, or Ammonia, generally combined with Sedatives, Carbolic, etc., 389.
 Baths of the same, with mucilage or tarry preparations.
 BALSAMS or BENZOIN tincture, BENZOIC Acid, locally (P. vulvæ).
 BELLADONNA suppository (P. ani).
 BORAX, BORACIC Acid, especially in quite hot solution, 299.
 CANNABIS Indica internally, in gradually increasing doses.
 CARBOLIC Acid in lotion or ointment, or in combination; sometimes internally.
 CHLORAL, with Camphor, or in lotion 4 gr. to the oz.
 COCAINE, 2 per cent., with cocoa-butter, etc., or hypodermic.
 CONIUM ointment, sometimes with Carbolic acid or Creasote.
 Diet, extra nutritious in former (Prurigo), bland in latter. COD Oil.
 GALVANISM. Massage. GELSEMIUM.
 HYDROCYANIC Acid, Cyanides, Cherry laurel water, in lotion or ointment (often combined), 331.
 IODINE tincture locally, in chronic forms, 97. IRON Perchloride in congestive cases, 636.
 LEAD lotion or Lactate in the more acute forms, 778.
 LIME Water; chalk ointment, with Tar, 576—chloride internally, 580.
 Menthol, solid, or $\frac{1}{2}$ dr. to $1\frac{1}{2}$ oz. of Spirit, or to $\frac{1}{2}$ oz. of ointment, with Oil and Chloroform.

PRURIGO, PRURITUS (*continued*).

MERCURIAL ointments (P. ani.). Hot solution of perchloride (12 gr. to the pint), 697.

Mineral waters: Sulphated, 244; Earthy (Leuk), 288; Sulphur (Schinznach), 281; "Indifferent" (Schlangenbad), 227.

NAPHTHOL solution with spirit or ointment, 2 to 5 per cent. Epicarin, 10 per cent. (for parasitic cases).

NITRIC Acid, dilute, lotion $\mathfrak{z}\text{i}$ to $\frac{1}{2}$ pint; or with Liq. Carbonis, or Prussic acid, 338.

PILOCARPIN, preferably by the skin. "SANITAS" in lotion, 1 to 2 or 4 parts of diluent. Terebene, 1 to 8.

SALICYLIC Acid, $\mathfrak{z}\text{ij}$ to 8 oz. of diluent, with Borax and glycerin.

SILVER Nitrate in solution to chronic patches, 460.

SOAP Spirit firmly rubbed in daily (chronic cases), washed off, and emollient applied after; also Menthol and antiseptic soaps.

SULPHUR ointment with Tar in chronic cases; Sulphurated potash, in lotion, 36.

SULPHURIC Acid (dilute) lotion, 1 to 3 dr. in 8 oz., also internally, 360.

SULPHUROUS Acid as paint, or 1 to 2 or 4 of water, 367; Sulphites, $\frac{1}{2}$ to 1 oz. in 8 oz.

Pix Liquida, Liq. Picis Carbonis.

THIOL, 10 per cent. paste with Zinc oxide (P. ani). THYROID extract in chronic congestive conditions.

v. Scabies, etc.

PSILOSIS.

MERCURIAL Perchloride as antiseptic, 722. Milk diet.

PSORIASIS.

ACETIC Acid to chronic patches, separates scales and stimulates, may cause pain, 295.

ALKALIES, Soda, Borax, Potash carbonates, mostly in bath, 216.

ANTIMONIAL Tartrate in acute inflamed cases, 430.

ARSENIC, in subacute and chronic stages in increasing doses, 520.

Baths, alkaline, or with Permanganate, 216. Earthy (Leuk), 288; Sulphur (Harrogate), etc., 274.

Blistering fluid (like acetic acid).

CARBOLIC Acid, CREASOTE, CADE Oil, generally in ointment.

CALCIS Lin., with 1-2 p. c. Carbolic acid in irritable inflamed cases.

CHROMIC Acid, dilute, 308. (P. linguæ.)

CHRYSAROBIN in ointment or in watery paste covered by collodion, (to patches only) also in plaster or in chloroform solution ($\mathfrak{z}\text{i}$ or $\mathfrak{z}\text{ij}$ ad $\mathfrak{z}\text{i}$), or in "Salve-stick" (Brooke).

COD Oil in thin or weakly subjects, especially children. Glycerin.

Electricity in chronic cases.

IODIDES internally in full doses, especially in gouty cases, 101.

IODINE solution, strong, 15 m with Carbolic solution 15 m, to 1 oz. of Boric ointment. Aristol ointment, 10 p. c., 121.

MERCURIAL ointments, white or red precipitate, or iodide, 1 part to 8, especially for the face or scalp, 97.

MERCURY sometimes, internally, or by Perchloride injections, 696.

NITRIC Acid, with Bitters, in weakly subjects, 340. PYROGALLIC Acid, 1 dr. to 1 oz., of lard to small patches carefully (stains).

PHOSPHORUS recommended by some, but is uncertain, 64. SALICIN.

SALICYLIC Acid ointment, 10 to 40 gr. in the oz., or with Chrysarobin.

SOAP, soft, and in tincture with Oil of Cade; soap medicated with Resorcin, Tar, Salicylic acid, etc.

SULPHUR in compound ointment, especially of Iodide, 36, 97, or in bath, 44.

TAR ointment, or Liq. Picis with Mercurials, or added to alkaline bath. THYMOL ointment, $\frac{1}{2}$ to 3 dr. in the oz. TURPENTINE internally (Crocker).

PUERPERAL FEVER.

v. Fever.

PULSE of high tension.

AMYL and similar drugs.

CALOMEL in purgative dose, 706. Venesection.

PULSE intermittent.

ARSENIC in cardiac weakness from various causes, 517.

DIGITALIS. STROPHANTHUS. CONVALLARIA Majalis.

v. Palpitation.

PURPURA.

ALUM in passive cases, especially affecting mucous membranes, 406.

CALCIUM Chloride, in 15 to 20 gr. doses to commence with, soon lessening, 569.

ERGOT. HAMAMELIS. LEMON. GALLIC Acid.

IODINE and iodides to be *avoided* as possibly causative, 76.

IRON Sulphate, perchloride or arseniate, in later stages with large plaques, 630.

POTASH Nitrate or bitartrate, 10 to 30 gr. doses; chlorate in small doses only, if at all, 809.

SUPRARENAL extract, locally and internally.

TURPENTINE, one of the best remedies in all forms.

v. Hæmorrhage.

PYÆMIA.

Alcohol.

AMMONIA by intravenous injection in extreme cases, 390.

Anti-streptococcus serum.

BORIC Acid, 300. EUCALYPTUS Oil, 5 m doses or with Olive Oil by skin.

CHLORINE solutions, 162.

PILOCARPINE (as eliminant) by skin.

POTASH Permanganate in acute, Potash solution in chronic cases.

QUININE, in full doses.

SALICYLIC compounds.

SULPHOCARBOLATES, Sulphites, Sulphurous acid, in full doses, 374.

TURPENTINE, antiseptic, stimulant.

PYELITIS.

BENZOIC and BORACIC Acids.

BUCHU and similar infusions.

CANTHARIDES tincture in drop doses.

EUCALYPTUS Oil, 3 m doses; tincture, $\frac{1}{2}$ to 2 dr.

LEAD Acetate has benefited.

SALICYLATES. SALOL. UROTROPIN.
v. Calculus, renal.

PYREXIA.

v. Fever.

PYROSIS.

ACIDS in small doses *after* meals, when secretion neutral or alkaline, 318.

BISMUTH Salts; if acidity marked, add Soda or Magnesia, 555.

CALUMBA and Bitters as adjuncts.

MANGANESE Oxide, said to act better than Bismuth and without constipation, but is not well taken, 761.

RESORCIN, 3 to 5 gr. doses, good.

SULPHUROUS Acid and sulphites act best in fermentation cases, 378.

v. Acidity, Dyspepsia.

QUINSY.

ACONITE, ANTIMONY early, 429.

BELLADONNA Inhalations with Benzoin, etc.

GUAIACUM. SALICYLATES.

v. Abscess, Tonsillitis.

RACHITIS.

COD-LIVER Oil, cream and fatty foods.

IODINE tincture, or as Ammonium salt, or with Iron, if it agrees, 102.

IRON, as iodide, phosphate, citrate (or wine, in mucous diarrhœa), perchloride to discharging glands or ulcers, 659.

LIME Saccharate, phosphates, sulphocarbols, or in organic or vegetable combination, 581.

Meat, raw.

Mineral waters: Muriated for bathing, 218-9; Alkaline, Earthy, Chalybeate and Arsenical (La Bourboule) for drinking, 271.

NITRO-MURIATIC Acid baths, conjoined with other remedies, 344.

PHOSPHORIC Acid for debility, sweating, etc., may be given with phosphates, 354. PHOSPHORUS, 64.

QUININE. Water, especially for cold sponging or sea-bathing, 170, 211.

v. Syphilis (a possible complication), Diarrhœa, Convulsions, etc.

RANULA.

CHROMIC Acid in solution to inner wall—requires care, 303.

IODINE tincture recommended for injection, but not satisfactory, 93.

RAYNAUD's disease.

Alcohol. ARSENIC, *cf.* 517.

CANNABIS Indica as anodyne.

Galvanism, one pole to the affected part in water. Massage. Movements.

PHENAZONE for pain. STRYCHNINE as tonic.

v. Albuminuria, Diabetes, Syphilis or other possible causes.

RECTUM, Inflammation of.

Oil injections with Bismuth, Carbolic acid, Hazeline, etc.

v. Anus, Hæmorrhoids.

RETENTION of Urine.

Catheterism. Surgical.

Hot bath. Hot water injections.

Ice in rectum in some cases.

v. Brain, Spine, Hysteria, Prostatitis, etc.

RHEUMATISM, acute.

ACONITE. CIMICIFUGA, especially in muscular forms.

ASPIRIN, 15 to 30 gr. doses, 3 to 4 hourly till pyrexia lessened; alternate with Alkalies in severe cases.

Blister over or near affected part.

CALOMEL purge, followed by salines.

Heat,—hot air bath and hot pack.

Turkish, Vapour, Sun, etc., 180-5.

IODIDES, if given, generally combined with Potash salts and Ammonia in effervescence, 100.

IRON Perchloride tincture in some cases, but not generally, 643.

Lime juice, 6 to 8 oz. daily, more used formerly.

MERCURIALS sometimes for complications, *q.v.*

OPium may be required, generally best as Dover's powder or Morphia.

PHENAZONE, PHENACETIN, CITROPHEN, etc., antipyretic, analgesic.

POTASH Bicarbonate, nitrate, citrate, in full doses, often with Quinine and in effervescence, 803.

SALICIN, SALICYLATES, like Aspirin.

SODA Salts in bath or compress, sometimes internally, 827.

VERATRUM Viride, like Aconite.

ZINC Cyanide has been used, 855.

v. Pericarditis, etc.

RHEUMATISM, chronic or sub-acute.

AMMONIA in liniment or as vesicant locally, 888.

Anodyne liniments, oleates, etc.

ARSENIC improves capillary circulation, lessens pain, *cf.* 508.

BENZOIC Acid and compounds, especially if urine alkaline.

BROMIDES of Ammonium, Lithium, Potassium, etc., for insomnia, 151.

CADMIUM Sulphate has been advised, but evidence little, 562.

CAJEPUT as rubefacient liniment.

CARBONIC Acid baths, 805.

COD-LIVER Oil. GUAIACUM.

Galvanism. Galvanic baths, 185; High-frequency currents.

Hot-air baths, Tallerman-Sheffield, Radiant, 184; Turkish, 181; Hot and cold douche, 172. Pine, 216.

Hot sand. Terebene.

IODINE, locally, 90; internally and as Iodides or Hydriodic acid, 100.

IRON in various forms, and long continued for anæmia, etc., 644.

METHYLENE Blue (tetramethylthionine), especially in gonorrheal cases, 1 to 2 gr. pill (colours urine).

Mineral Waters: Indifferent, Alkaline, Muriated, Sulphur, 219.

Massage. Moor-baths, 241.

PHYTOLACCA Root tinct., 3 to 10 m; RHUS Tox. tinct., 2 to 10 m.

SULPHUR frictions and baths: internally, 5 gr. doses, 41-4.

POTASH Salts, as in acute cases, in combination, 803.

SERPENTARIA and similar infusions.

TURPENTINE, internally and as liniment, often useful.

RHEUMATOID.

v. Arthritis.

RINGWORM.

v. Tinea.

RODENT ULCER.

Caustics, especially Chromic acid, 309, and Zinc Chloride, 849.

Cautery. Operation. X-Rays.

RÖTHELN (German measles).

v. Measles.

ROUND WORMS.

v. Ascaris.

RUPIA.

v. Syphilis.

SARCINÆ.

RESORCIN. SULPHITES. *v.* Vomiting.

SCABIES.

BALSAM of Peru. CARBOLIC Oil, 1-20. COPPER Oleate, 10 per cent., 349.

LIME Chloride, 1 oz. to 1 pint of water, or caustic lime with Sulphur, diluted, 576.

MANGANESE Oxide, 2 dr. to the oz. of ointment, 758.

SCABIES (*continued*).

NAPHTHOL 15, with Chalk 10, Soft Soap 50, Lard 100 (or without soap). EPICARIN (non-irritant naphthol), 10 per cent. ointment.
 POTASH Carbonate in Sulphur ointment, 34; Potash soap, 800.
 STORAX, with oil and simple ointment equal parts, or spirit, 1 to 2.
 SULPHUR in various forms, 34.
 SULPHURIC Acid, 1 dr. to the oz. of ointment, cures but irritates, 360.

SCARLATINA.

ACETIC Acid dilute, internally, and for sponging, 296.

ACONITE in early stages.

ALKALIES, often in effervescence, 805.

AMMONIUM, especially carbonate, also benzoate and acetate, 392.

ANTIMONY sometimes, if rash scanty or suppressed, 427.

BELLADONNA in the milder forms, and as prophylactic.

CARBOLIC Oil, 1 in 50, later 1 in 25, for anointing; also with glycerin and Borax as spray to throat.

CHLORINE solution as gargle, sometimes internally, 160-2.

CINNAMON decoction said to lessen complications (ear and kidney).

EUCALYPTUS Oil in 3-5 m doses, or mixed with spirit, inhaled or vaporised for bad throat, also with Almond oil, 4 parts, and Cinnamon oil, $\frac{1}{4}$ part, for anointing.

HYDROCHLORIC Acid, internally and to fauces, especially in asthenic cases with sloughing, 320; Potassium chlorate often added.

Ice to throat. Inunction as above.

IRON Perchloride tincture internally, and to the fauces (with glycerin) best in malignant forms; Ammonium acetate or Potash citrate well combined, 642.

MERCURY with chalk in small frequent dose, especially for severe throat inflammation; also the Perchloride with Potassium iodide, and in spray, 710.

OXYGEN for collapse or cyanosis.

PILOCARPIN (cautiously) for dry skin and ill-developed rash.

PHENAZONE and congeners, also QUININE, for pyrexia—the latter in asthenic cases.

POTASH Chlorate, useful for throat condition in gargle and by the mouth (in moderate doses only), also the Permanganate, 805-8.

SULPHUROUS Acid internally, also in spray and fumigation, 377.

SULPHOCARBOLATES. SALICYLATES. Water in various forms of sponging, pack, compress and bath, 201-3; with Mustard, in cases of scanty or suppressed rash.

SCIATICA.

ACONITE and other anodyne liniments, Belladonna, Chloroform, Menthol. AGATHIN, 4-8 gr. thrice daily.

Acupuncture in course of nerve.

Aquapuncture, or better with normal saline solution, m 20 to 30.

ARSENIC for deep-seated pain, intermittent, worse at night, often relieved by heat, 510.

Blister. Dry cupping. Caution (Paquelin). Nerve stretching. Ether or Ethyl-chloride spray. Electricity, 185, 204. Hot-air or Turkish bath, 181. Hot douche, 173.

IODIDES in markedly rheumatic cases, with Colchicum, 102.

Mineral waters and baths as for rheumatism.

MORPHIA and other anodynes, Cocaine, Chloroform, etc., best by the skin (deep injection).

PHENAZONE, Phenacetin, Exalgin and similar analgesics.

Purgatives important, if required.

Rest to limb by long splint (axilla to ankle). SALICIN. SALICYLATES.

SILVER Nitrate solution for deep injection, 402. SULPHUR frictions in chronic cases, 37.

TURPENTINE acts best in elderly asthenic rheumatic cases; full doses, with due care. *v.* Neuralgia.

SCLEROSIS, Disseminate, Lateral.

ARSENIC deserves trial, but prognosis unfavourable.

Baths, electricity, massage.

BROMIDES for excitable conditions.

GOLD Chloride with Sodium, 538.

HYOSCIN for tremor, insomnia, etc.

IODIDES especially, but not only, in syphilitic cases, 99, 102, 110.

MERCURY Perchloride, do., do., 715.

SCLEROSIS, etc. (*continued*).

SILVER Nitrate or chloride has seemed of use in arresting, *cf.* 467.
Spermine (Poehl's 2 per cent. solution), 15 m by deep injection daily.

SCORBUTUS.

v. Scurvy.

SCROFULA (usually Tuberculosis, *q.v.*).

ARSENIC in chronic cases, 506.
COD-LIVER Oil and hygiene.
GOLD Chloride, in ulceration, bone and gland disease, 537.
HYDRASTIS, in lotion for the same.
IODINE, locally, 84; internally, 102.
IODOFORM, Aristol, etc., as local applications, 118-21.
IRON, best with Iodine or Lime, 659.
LIME Water, phosphate, chloride, sulphide, locally—internally, 582.
MERCURY with chalk, $\frac{1}{2}$ to 1 gr. doses about twice daily, 717.
Mineral waters: Muriated, 249; Iodised, 263 (Kreuznach, Woodhall), Sulphur, 274.
POTASH Caustic, for ulceration, 797; the solution or chlorate internally, 807.
SARSAPARILLA, CHIMAPHILA and similar decoctions.
Sea air (Margate). Sea-bathing, 211.
SODA Caustic, like Potash; Salt solution (strong) to enlarged glands, 825; also internally, 832.
Surgical, v. Glands.

SCURVY.

ALUM solution for the gums, *cf.* 403.
CALCIUM Chloride for hæmorrhage, 5-5. CHLORINE and other antiseptic gargles for fætor, 160.
CITRIC Acid, orange and lemon juice.
CINCHONA, Quinine and other bitters.
Fresh vegetables, fruit, milk, raw beef juice, horse-radish (*omit* sterilised and peptonised foods).
IRON wine with cod oil, when acute stage passed, 630.
POTASH Chlorate for the gums, 809.
SILVER Nitrate and other astringents for the same, *cf.* 457.
Stimulants for syncope.
SUPRARENAL extract for hæmorrhage. TANNIN in various forms. Tannalbin, Catechu, etc.

v. Gingivitis.

SEA-SICKNESS (prophylactic).

Aperient before starting.
ATROPINE Sulphate, $\frac{1}{150}$ with Strychnine $\frac{1}{100}$ gr. by the skin.
BROMIDES, 5 to 10 or more gr. doses commenced beforehand, 148; well combined with Chloralamide ("Chlorobrom" has 30 gr. of each in 1 oz.); or with CHLORAL for one hypnotic dose.
CAPSICUM, Tr. 1 m doses frequently. Champagne, iced.
HYOSCINE Hydrobromide, $\frac{1}{100}$ gr.
NITRO-GLYCERIN, m 1 of a 1 per cent. solution (or tablet), hourly for 2 to 4 doses: may cause headache, etc.
PHENAZONE, small doses with Cocaine, good.

v. Vomiting.

SEBORRHOEA.

Antiseptic soaps: Resorcin, Salicylic, Sulphur, Mercurial; also Potash soap with Spirit (not too frequently), 800.
BORAX, or Boric acid lotion or wash, generally with Camphor and Rosemary, *cf.* 298.
CARBOLISED Oil, 2 per cent. to soften crusts. ICHTHYOL with Lanolin.
IODINE tincture to scalp in subacute or chronic dry stages, 97.
IRON often needed for anæmia, 644.
MERCURIAL Perchloride, or periodide in weak lotion, 1 in 1000, or ointments of oxides or Am.-chlor.
RESORCIN 2 to 5 per cent in lotion with spirit, or in ointment, often with Sulphur.
SULPHUR with Carbolic or Salicylic acids, aa gr. 15 to 1 oz., 36.
TANNIN, \mathfrak{z} i to the oz. of ointment, especially in moist scalp cases.
v. Eczema, Dyspepsia.

SEPTICÆMIA.

v. Pyæmia.

SEXUAL DEBILITY. v. Impotence.

SEXUAL DESIRE, Excessive.

Baths, sedative. BARIUM, 544. CAMPHOR. BROMIDES, 149. DIGITALIS. LUPULIN, 5 to 10 gr. doses, often with Bromides.
SALIX Nigra, fluid ext., $\frac{1}{2}$ to 1 dr.

SHINGLES.

v. Herpes.

SHOCK.

AMMONIA, 391. ETHER and other Stimulants, external and internal. Saline transfusion or injection. STRYCHNINE, by the skin.

SKIN DISEASES.

v. Acne, Eczema, Lupus, Tinea, etc.

SLEEPLESSNESS.

v. Insomnia.

SMALL-POX.

ANTIMONY in lung complications or active delirium, 427.
CARBOLISED Oil, 2 to 8 per cent. as paint. Collodion, do.
EUCALYPTUS Oil, 1 in 5 of Olive oil, for inunction or paint.
IRON Perchloride with glycerin, locally and internally, 636-43.
LIME Water or liniment locally, 576-7; Sulphide, internally, 39.
MERCURIAL ointment and plaster have been applied, but are not advisable; a spray, 2 per cent. of perchloride better, 697; grey powder, in small, frequent dose, 710.
SILVER Nitrate, 20 gr. to the oz., applied by needle puncture, 451
SULPHUROUS Acid locally, internally, and as fumigation, 372-85.
Water for antiseptic warm sponging, compress, pack or bath, 203.
For complications. *v. Hæmorrhage, Septicæmia, etc.*

SNAKE BITE.

Serum injection (Antivenene), 10 c.c. with ligature and irrigation of wound.
AMMONIA, 389.

v. Bites.

SPASM.

AMYL and other Nitrites relax spasm of capillary vessels, 836-7.
ANTIMONY in nauseant doses for hernia, rigid os uteri, etc., 437.
BELLADONNA. OPIUM and alkaloids. BROMIDES relieve tenesmus and reflex spasm, 147.
CHLORAL, CHLOROFORM, ETHER and other anæsthetics. OXYGEN, 16.

SPERMATORRHOEA.

BELLADONNA. BROMIDES in the plethoric with undue erections and local congestion, 134, 149.
CANTHARIDES in drop doses, or as blister over lumbar centre.
DIGITALIS. Electricity. LUPULIN. IRON Perchloride tincture for young weakly subjects, 635.
NUX Vomica and its alkaloids in some asthenic cases.
PHOSPHORUS, Phosphoric acid in irritable, weakly conditions, 60.
SALIX Nigra as sedative, fl. ext., $\frac{1}{2}$ to 1 dr. doses.
SILVER Nitrate, strong solution to the prostatic urethra, 454.
Spermin (Poehl) essence for internal use, 2 per cent. solution for deep injection. Orchitic fluid.
Surgical, as for hæmorrhoids, phymosis, prostatitis, etc.
Water cold, in compress, sitz-bath, douche to spine, etc.
v. Hypochondriasis, Impotence.

SPHINCTERS, paralysis of.

ARNICA tincture, 5 to 10 m doses.
COCCULUS Ind. tincture, 1 to 5 m.
v. Enuresis.

SPINA BIFIDA.

IODINE, locally injected, 89.

SPINAL WEAKNESS (mainly muscular).

ACETIC Acid with spirit, for sponging locally, 296.
Douche, spinal, 172. Massage. Exercises. Rest. Tonics.
v. Debility.

SPINE, congestion or irritation of.

BELLADONNA (locally).
BROMIDES in acute cases with pain and spasm, 133-53.
Counter-irritation, Cupping.
ERGOT. IODIDES in traumatic cases.
Water in douche, affusion or compress, 208.
v. Ataxy, Sclerosis, Myelitis, Neurasthenia.

SPLENIC ENLARGEMENT (malarial, non-febrile).

BROMIDES useful in several forms, 154. Douche, 173.

SPLENIC ENLARGEMENT (*contd.*).

ERGOT. HYDRASTIS. QUININE.

IODINE and Iodides externally and internally, 110.

LEAD Iodide in ointment, 780.

MERCURIAL Iodide ointment, but not free from risk, 699.

Mineral waters: Muriated, Sulphated-alkaline, Iodo-bromated, Arsenical, 219-20.

v. Ague, Leucocythæmia.

SPRAINS.

AMMONIUM Chloride lotion, 2 dr. to 4 or 6 oz. of spirit and water, 389.

ARNICA, infusion of flowers for fomentation, 2 dr. to 8 oz.

CAPSICUM, after the acute stage.

IODINE locally in tincture or ointment, in later stages.

LEAD and Opium lotion—bandage if bearable.

Douche. Hot bathing for pain and swelling. Cold in quite early and in later stages. Massage. Exercises later.

SULPHUROUS Acid lotion, 1 in 8, after a spray of pure Acid, 368.

SPRUE.

v. Psilosis.

STINGS.

AMMONIA solutions, dilute, 389.

CAMPHOR Spirit. CARBOLIC Acid, lotion, 2 to 5 per cent. with spirit.

LEAD lotion, generally with Carbolic.

LIME Water with oil (Lin. Calcis).

v. Bites.

STOMACH dilatation or catarrh.

v. Gastric.

STOMATITIS.

CARBOLIC Acid dilute, 2 to 5 per cent. locally.

EUCALYPTUS, decoction of leaves, or tincture 1 to 2 dr. in 8 oz.

HYDROGEN Peroxide, 2 per cent., 19.

POTASH Chlorate, 10 or more gr., or Permanganate, $\frac{1}{2}$ gr. to the oz., 799.

HYDRASTIS, 1 dr. to 8 oz.

TANNIN, glycerin of.

v. Aphthæ.

STROPHULUS (red gum).

Baths, alkaline, mucilaginous, followed by Vaseline inunction.

Diet. MAGNESIA.

Soothing, slightly astringent dusting powders, to which THIOI may be added (2 to 3 per cent.); or lotions as Lead and Carbolic.

v. Erythema, Perspiration.

STRUMOUS GLANDS.

v. Lymphadenitis, Scrofula.

STRYCHNINE Poisoning.

Alcohol to narcosis.

AMYL Nitrite has proved effective in animals.

BROMIDES in full doses, 143. CAMPHOR. CHARCOAL.

CHLORAL. CHLOROFORM. IODINE, 84.

OPIUM and its alkaloids.

OXYGEN and artificial respiration, to promote elimination, conjoined with Amyl, 16. TANNIN.

STYE.

PULSATILLA Tr., 1 dr. to 4 oz. lotion.

v. Hordeolum.

SUNSTROKE.

BELLADONNA. ERGOT. GELSEMIUM.

Cold affusion or enemata. Ice cap.

Leeches. NITRITES. PHENAZONE.

(Alcohol to be avoided).

v. Congestion, Cerebral.

SUPPRESSION of Urine.

v. Nephritis, Calculus, etc.

SUPPURATION.

v. Abscess, Boil.

SWEATING, excessive.

v. Perspiration.

SYCOSIS MENTÆGRA (folliculitis barbæ).

ARSENIC has been given internally, and applied locally, 2 dr. of solution to 10 of Glycerin, 525.

BISMUTH Oleate to inflamed patches, 349. BORACIC Starch poultice, do.

BORIC lotions (saturated), 298.

CARBOLIC Oil, 1 in 10 (or 5) to soften crusts and disinfect.

CHRYSAROBIN ointment may be required for obstinate patches.

Epilation if needed, and scarification. Shaving as a rule.

ICHTHYOL ointment, 10 to 30 p. c.

IZAL, $\frac{1}{2}$ to 1 per cent. solution in water, a good application.

SYCOSIS MENTÆGRA (*continued*).

IODOFORM and congeners, Europhen, Loretin, 10 to 15 gr. to the oz. of ointment, 122.

MERCURY Oleate, 2 to 5 p. c., 349; Nitrate ointment dilute, 695.

PETROLEUM with Oil, equal parts for mild cases.

POTASH solution to chronic patches, followed by Boric ointment, 799.

RESORCIN lotion, 1 to 2 per cent. if inflamed—10 per cent. later.

SALICYLIC paste. Soaps, antiseptic.

SULPHIDES. Sulphocarbolates.

SULPHUR Iodide, 96, or plain Sulphur ointment diluted at first, 36.

TANNIN added to last, in paste.

v. Tinea.

SYNCOPE.

ACETIC Acid inhalation, 296.

Alcohol by mouth, rectum or skin.

AMMONIA by the mouth, or intravenous injection, 391.

AMYL Nitrite. ETHER. LAVENDER.

Artificial respiration. ATROPINE by the skin, or STRYCHNINE.

Position recumbent, or head lowered. Saline transfusion.

Water by affusion, hot or cold.

v. Chloroform poisoning.

SYNOVITIS (Hydrarthrosis).

ACONITE in acute stages. Cold. Leeches. Aspiration in chronic cases. Blisters.

IODINE tincture, locally, or in lotion or injected, 90. Iodides internally.

LEAD lotion for acute cases, 778.

Massage—Movements later.

MERCURY in oleate, ointment or plaster (with Morphia), 699.

Saline purge and SALICYLATE in acute cases.

SILVER Nitrate, applied round joint, or by deep injection, 461-2.

Splint at first. Pressure in chronic cases. Surgical.

v. Rheumatism.

SYPHILIS.

ARSENIC in late stages for anæmic cachexia, or skin complication, 508.

CADMIUM Sulphate, $\frac{1}{2}$ to $\frac{1}{2}$ gr. (doubtful), 562.

CARBOLIC Acid for local disinfection.

CHROMIC Acid for tongue ulceration and mucous patches, 308.

COPPER Sulphate in secondary and tertiary cases, 606.

GOLD Chloride, especially in later stages; alternative to mercury, 536. Hydro-therapeutics.

IODIDES in the later stages, sometimes large doses required, often with Mercury, 99; said to act better combined with Nitrites.

IODOFORM, Europhen, etc., as local applications or injections, 117.

Iodol also given in 15 gr. doses, 122.

IRON Potassio-tartrate, or Iodide, especially in later stages, 695; also in mineral waters, 263.

MERCURY in lotion, ointment, plaster or bath, for ulcerations and eruptions, 700; internally in various forms, 713; generally in small doses, long continued, or by the skin, 723-7; Mercuriol. 728.

NITRIC Acid locally for sloughing, 336; NITRO-HYDROCHLORIC Acid for cachexia, 343.

PILOCARPINE (eliminant) by the skin.

POTASH Chlorate, especially for children, Bichromate for throat and eye symptoms, 811.

SARSAPARILLA, Guaiacum, Dulcamara, Mezereon, Sassafras, Stillingia and similar "Wood drinks" useful in later stages as diaphoretics, etc., if in effective doses.

SULPHUR as adjuvant, especially with warm baths, 42-4; as at Aachen, Uriage, etc., 278.

Sulphide (Calcium) of service in laryngitis, after Mercury, 40. Sulphites in later stages, 374.

SULPHUROUS Acid lotion, gargle, 369.

TABES DORSALIS.

v. Ataxia.

TABES Mesenterica.

v. Scrofula, Peritonitis.

TAPEWORM.

CHLORAL Hydrate, or Chloroform combined with any of following. COPPER Sulphate, small doses for 10 days, Castor oil as required, 603.

FERN, Male, ethereal extract, 1 dr. doses, fasting; purge before or after.

KAMALA, 2 dr. or in tincture.

KOUSSO, $\frac{1}{2}$ oz. of flowers, infused.

NAPHTHALINE, 10 to 20 gr., followed by purge. THYMOL, 15 gr. do.

TURPENTINE, $\frac{1}{2}$ oz. doses, do., all need caution.

TAPEWORM (*continued*).

- POMEGRANATE Root bark, decoction 2 oz. or more.
 PELLETIERINE Tannate, 6 to 8 gr. doses, purge after.
 PUMPKIN Seeds, $\frac{1}{2}$ oz. in electuary (for children).

TENESMUS.

- CONIUM ointment.
v. Spasm, Dysentery, Prostate.

TETANUS.

- Alcohol in large quantity. Nutrition important. Alkaline diuretics.
 Antitoxin, 100 cc. daily, commenced early, of marked service in curable cases.
 AMYL Nitrite for spasm.
 BARIUM as lessening reflex, 544.
 BROMIDES with CHLORAL, Chloroform, and other sedatives, *cf.* 154.
 CALABAR Bean extract, $\frac{1}{16}$ to $\frac{1}{4}$ gr. freely, of apparent service.
 CARBOLIC Acid, 1 per cent. injected (Bacelli).
 CURARE, $\frac{1}{4}$ gr. by the skin.
 MERCURY Perchloride or iodide in local bath for disinfection of wound, 693. OXYGEN, 16.
 OPIUM and alkaloids. PARALDEHYDE.
 POTASH Carbonate, internally (Stütz), and in bath; also permanganate.

TETANY, Infantile.

- Diet, and sometimes Thyroid feeding.
v. Rickets.

TETANY, gastric.

- Anti-spasmodics and lavage.
v. Gastric dilatation.

THROAT, sore.

v. Tonsillitis.

THROAT catarrhal, relaxed.

- ALUM in early acute or chronic congestive conditions, not at height of inflammation,—in gargle or insufflation, 403-4.
 AMMONIUM Chloride for granular forms, in lozenge or vapour, 394.
 BORAX, or Boric Acid with glycerin, in painful, congestive cases.
 CARBOLIC Acid, CATECHU or HYDRASTIS, diluted as gargle, paint or spray.

IRON astringent preparations, perchloride or sulphate, locally and internally, 635.

POTASH Chlorate, nitrate or permanganate in congestive cases as gargle.
 RED Gum lozenge or gargle.

SILVER Nitrate in weak spray or strong paint in later stages, 457.

SULPHUROUS Acid, 369.

TANNIN as paint, etc., often with Carbolic acid and Capsicum.

Water as compress; Salt water as gargle or for bathing, 214, 832.

ZINC Chloride or sulphate in spray or gargle, 851.

v. Tonsillitis.

THROMBOSIS.

- AMMONIA solution, 10 m frequently, with Potassium iodide, 391.

TINEA Tarsi.

v. Blepharitis.

TINEA circinata, T. tonsurans, T. favosa, T. sycosis.

ACETIC Acid, 1 part in 3, sometimes useful, 295. Blistering.

BORACIC ointment or saturated solution in Ether and Spirit, *cf.* 299.

CARBOLIC Acid oil or ointment.

CHRYSAROBIN alone, or in compound ointment 5 per cent., with Ichthyol 5, Salicylic acid 2; requires care (stains).

COCCULUS Ind. decoction or ointment, 80 gr. to the oz.

COPPER Sulphate lotion, 10 gr. to the oz.; or oleate, 10 per cent., or more, 349. CREASOTE.

CROTON Oil for pustulation of chronic recurrent patches.

Epilation sometimes or shaving.

FORMALIN, 10 p. c. as paint (painful).

IODINE tincture for recent cases, or 1 part of Iodine in 4 of oil of Tar, as paste, 97.

IRON Perchloride tincture, painted on early cases, or after more active remedies, 636.

Lanolin with Parolein, etc., a good basis for ointments.

LIME Water or lotion of chloride, $\frac{1}{2}$ oz. to 10 oz. as compress, 576.

LIQ. PICIS Carbonis.

MERCURY Perchloride lotion, 1 to 2 gr. in the oz. with spirit, or as ointment, 694; also the oleate, 5 to 10 per cent., or Ammonio-chloride with Sulphur, 36.

TINEA, etc. (continued).

PETROLEUM locally, as prophylactic and nutrient to the skin.

POTASH Sulphocyanide, $\frac{1}{2}$ oz. in 8 oz. for lotion. Potash and antiseptic soaps; also caustic Potash 9, with Carbolic acid 24 gr. to the oz. of ointment.

SALT in superficial cases.

SALICYLIC Acid, 15 gr. to the oz. of Ether, good in early cases, or 1 dr. to the oz. of ointment.

SULPHUR in ointment, generally combined with the last or with Mercury, 36; or as Iodide, 96.

SULPHUROUS Acid in full strength, or 1 to 2 or 4 of water and glycerin; or in the nascent form, 368, or as sulphite lotion.

THYMOL ointment, 10 to 30 gr. to the oz., or $\frac{1}{2}$ to 1 dr. dissolved in 1 oz. of TURPENTINE.

Exclusion of air may be combined with above treatments.

TINEA versicolor. v. Chloasma.**TINNITUS AURIUM.**

AMMONIUM Chloride, well combined with Bromide, of each 10 to 15 gr. AMYL and other Nitrites.

ARNICA tincture, 5 to 10 m doses in nerve cases.

BELLADONNA for congestive cases, sometimes with Aconite.

BROMIDES, or Hydrobromic acid, 311. Counter-irritation, Politzer bag, ear syringe, etc.

v. Vertigo.

TONSILS, enlarged.

ALUM, by insufflation, 404.

IODINE locally and internally; also Iodides, 85.

IRON Perchloride solution with glycerin, as paint, 635.

SILVER Nitrate, solid, pointed, pushed in, 457.

TANNIN in powder, or with glycerin.

TONSILLITIS.

ACONITE in small, frequent doses.

ANTIMONY, do., 429. ASPIRIN, as in rheumatism, like salicylates.

BELLADONNA, like aconite, and often alternately with it.

BENZON vaporised, mostly in ulcerative forms.

BORAX, with glycerin, as paint or gargle, *cf.* 299.

CAPSICUM in gargle, $\frac{1}{2}$ of tincture to $\frac{1}{2}$ pint of diluent, only in early stage, or malignant forms.

CARBOLIC Acid in gargle or vapour, especially when ulceration present.

COCAINE in paint or gargle.

EUCALYPTUS, do. Fomentations, Compress, Ice. Steaming.

GUAIACUM internally or in lozenge, in early stage.

HYDROCHLORIC Acid or Chlorine in ulcerative cases, 160, 317.

MERCURY with chalk, small frequent doses, 710.

POTASH Chlorate and nitrate in gargle, lozenge and internally; Permanganate for ulceration, *cf.* 799.

SALICYLATES often very serviceable.

SILVER Nitrate, but not in acute stages, 451. Protargol, Argylol,

2 to 5 per cent. paint or spray. SODIUM Bicarbonate locally, 827.

SULPHIDES and Sulphur waters in chronic follicular cases, 41.

SULPHUROUS Acid gargle or spray in catarrhal cases, 369.

v. Tonsils, Throat.

TOOTHACHE.*Local applications—*

ALUM in paste with Ether, 403.

CAPSICUM. CARBOLIC Acid and Collodion equal parts with 2 per cent. of Cocaine.

CHLOROFORM. CREASOTE. GINGER.

MENTHOL (liniment). OPIUM.

PYRETHRUM Root. SODIUM Carbonate in warm water, $\frac{1}{2}$ dr. to the oz., 827.

*Surgical.**Internally—*

Alcohol if inflammation not acute.

Aperients often effective.

ACONITE, small frequent doses.

BUTYL-CHLORAL, 3 to 5 gr. pill, repeated hourly for 4 to 6 doses.

GELSEMIUM tinct. 10 to 20 m do

PHENAZONE, PHENACETIN and congeners. Exalgin, $\frac{1}{2}$ -2gr. repeated.

TONGA, 1 dr. doses.

v. Neuralgia.

TORTICOLLIS.

GELSEMIUM or MORPHIA by the skin. Galvanism.

v. Rheumatism.

TREMOR.

HYOSCIN Hydrobromide, $\frac{1}{200}$ to $\frac{1}{100}$ gr.
v. Sclerosis, Alcoholism, Mercurialism, Paralysis.

TUBERCULOSIS.

v. Scrofula, Phthisis, Peritonitis.

TUMOUR, fibroid.

v. Fibroma.

TUMOUR, ovarian.

v. Cysts.

TYPHLITIS.

v. Appendicitis.

TYPHOID and Typhus.

v. Fever.

ULCERATION.

Bandage, rubber or elastic.

BENZOIN, tincture.

BORAX, Boracic acid, as lotion or ointment, 1 in 20, 299.

BROMIDES in powder to indolent ulcers, or ointment, 1 in 5, 137.

CALENDULA tincture, 1 part in 10 of water as lotion, or of vaseline as ointment. CALCIUM Chloride, 575.

CARBOLIC Acid in lotion or ointment.

CHLORINATED Soda, Liq. Chlori, 160.

CARBONIC Acid gas to atonic and gangrenous ulcers, 304.

CHLORAL lotion, 2 to 4 gr. in the oz.

CHROMIC Acid as caustic to phagedænic cases, 309.

COCAINE, 2 per cent. or more (in combination).

COPPER Sulphate to indolent ulcers; as injection in rectal cases, 600.

Electricity. Massage.

EUCALYPTUS ointment. HYDRASTIS.

HAMAMELIS for varicose ulcers.

Incision, scraping and other operations; skin grafting

IODINE, 94. Iodoform and congeners, 116-21, good, but not during acute inflammation.

IRON Perchloride in chronic indolent cases; also the carbonate powdered, 637.

LACTIC Acid, 1 in 2, especially in laryngeal cases, 346.

LEAD Acetate, 10 to 20 gr. in 1 oz. of water and lime water, when inflamed, 778.

Lead- or tin-foil to leg-ulcers, after disinfection.

LIQUOR PICIS Carbonis, diluted.

MERCURY in lotion, oleate or ointment for some indolent cases, and always for syphilitic, 700. Calomel fumigation, 728.

NITRIC Acid for sloughing, 336.

OPIUM, locally and internally.

ORTHOFORM, in powder.

OXYGEN locally, very effective in chronic cases, 8.

PEROXIDE of Hydrogen as cleansing antiseptic lotion, 23.

POTASH, Caustic, also chlorate and permanganate in lotion, 797-9.

RESIN ointment for indolent sores, sometimes Turpentine.

RESORCIN ointment or lotion, antiseptic and stimulant.

SALICYLIC Acid, *do.*, *do.*, or as Lassar's paste, with Zinc oxide and starch.

SILVER Nitrate solid to indolent cases, in lotion to discharging surfaces; the Iodide in uterine cases; also as Protargol and other organic compounds, 455-6.

SODA Caustic, or as Ethylate, 825.

SULPHUROUS Acid as lotion, 369.

TANNIN, but this coagulates albuminous discharge.

Water in various forms: compress, bath, and as Sulphur, Earthy, "Indifferent" and Muriated Spas, 219-21; Moor baths, 241 (Barèges, Leuk, Pfæfers, Franzensbad, etc.).

ZINC-Ichthylol gelatine, Zinc oleate or sulphate, 851.

URÆMIA. *v.* Nephritis, Convulsion.

URETHRITIS.

v. Gonorrhœa.

URTICARIA.

ALKALINE lotions, Borax, etc., with sedatives, 826. ADRENALIN.

ARSENIC internally for neurotic cases free from dyspepsia, 524.

BELLADONNA. BROMIDES as controlling vasomotor reflex, 149.

CALCIUM Chloride, full doses, 580.

BISMUTH or ZINC Oxides, etc., as dusting powder, which may be Camphorated or Carbolised, 552.

ICHTHYOL. LEAD lotion. Liq. PICIS.

MENTHOL, PRUSSIC Acid, locally, 331.

QUININE, RHUBARB, SALICYLATES.

v. Prurigo; also Dyspepsia, Rheumatism and other causes.

UTERINE CONGESTION, etc.

ARSENIC, both in torpid and menorrhagic cases, 519.

BROMIDES, especially at the climacteric, also in pregnancy, 149-53.

GOLD Chloride in chronic cases with amenorrhœa, etc., 537.

IODINE locally applied in various forms, 88.

Mineral waters: Alkaline, Vals, 231;

Muriated alkaline, Ems, 234; Sul-

phated, Franzensbad, 241; Muri-

ated, Kissingen, 249, Kreuznach.

v. Ovaritis, Endometritis.

VAGINISMUS.

COCAINE locally. CONIUM ointment.

BROMIDES locally and internally, cf. 147. Dilatation. Operation.

IODOFORM tampons, 118.

VAGINITIS.

Alcohol, camphorated.

ALKALINE and Boracic lotions injected, cf. 300.

BISMUTH compounds in lotion or pessary, 553.

LEAD lotion with Cocaine or Carbolic acid, 780.

v. Gonorrhœa, Leucorrhœa.

VARIOLA.

v. Small-pox.

VARIX, VARICOCELE.

Cold douche. Support by bandage, etc. Massage of scrotum to strengthen muscle. Galvanism. Surgical.

ERGOT. HAMAMELIS internally and locally with Spirit lotion.

IRON internally, or by injection, 634.

POTASH, Caustic, used formerly to obliterate vein, 797.

VERTIGO.

BROMIDES and Hydrobromic acid as modifying brain circulation, 311.

PRUSSIC Acid similarly, also lessening gastric irritation, 334.

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